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RECENT WORKS ON LICHENS.

By A. Lorrain Smith, F.L.S.

In the following pages, a summary is given of publications that were unavoidably omitted from the handbook "Lichens," and that have appeared since the manuscript was handed to the press in the beginning of 1920. During the war-years and for some time after, it was difficult or impossible to get hold of the works of continental botanists. A different apology is due in the case of Sernander's ecological works: in that case it was the language difficulty that barred the way at the time.

Two valuable papers dealing with recent literature appeared in 1921: one by Bioret which reviews lichenological work from 1910 to 1919; and one by Paulson which is a résumé of British Lichenology from 1911 to 1920.

In this survey purely systematic publications have not been included: these are both numerous and varied; the essential work of knowing and classifying the plants has not been neglected. It may, however, be permitted to direct attention to Bernt Lynge's (1921) Studies of Norwegian Lichens, full of helpful notes, to the Handbook of British Lichens by A. Lorrain Smith (1921) which provides a key based on the Monograph of British Lichens, and to W. Watson's Determination of Lichens in the Field (1922), a key to the genera and to many species of common British lichens based on field characters and intended to be of service to field botanists especially in their study of ecology.

LICHEN GONIDIA.

Several writers have dealt with the types of gonidia present in the lichen thallus, and with their behaviour in culture media. Letellier (1917), a pupil of Chodat, has devoted himself especially to this research. He isolated a *Nostoc* from *Peltigera* sp., and in culture he found that nitrates and ammonium salts were utilized by the alga but not peptone or glycocol. Glucose and sugars generally favoured growth, a result opposite to that obtained by Chodat and others with free Cyanophyceae. Eva Mameli (1920) in her chemical study of the blue-green lichens decided that in the lichen thallus the algal constituents suffered no important change except occasionally in the size of the cells. Linkola (1920) has cultivated *Nostoc* gonidia from eight different species of *Peltigera*: they grew well and formed hormogonia which developed into spores or into *Nostoc* colonies. Linkola refers them all to *Nostoc punctiforme* Hariot. The only variation

of importance occurred in the gonidia of *Peltigera malacea*, and that he thinks may indicate some specific difference or only some particular physiological race.

Waren (1920), a pupil of Elfving, has chiefly been occupied with bright-green gonidia which he cultivated from twenty-one different species of lichens. He tested them on different nitrogenous media and found that they grew most freely on amino-acids. He classifies the gonidia of most of our common lichens under the genus *Cystococcus* which he divides into two sections, *Eucystococcus*, in which there is vegetative division (*Protococcus*), and *Eleuterococcus*, the species of which apparently form autospores in the cultures. The gonidia from the different species show differences of form and colour in the culture colonies which leads him to think that each lichen species has its own particular gonidium. Bioret (1921) however thinks that in organisms so polymorphic as green algae it is impossible to determine aberrations as specific or even racial. Waren found that the gonidia in *Xanthoria parietina* from Finland differed from those of the species collected in Holland.

Waren's views on the gonidium do not accord with those of Paulson (1921) published in last year's Transactions of this Society. The latter dealt with the living thallus and found in a very large number of lichens the same type of sporulating gonidium present which he refers to *Chlorella* sp.

SYMBIOSIS OR PARASITISM.

The nature of the association between the two organisms in the lichen thallus is still under discussion. Paulson (1921) maintains the necessity of regarding both organisms living in a healthy condition as symbiosis, as neither succumbs to the other. The alga is not parasitized; it sporulates abundantly at certain seasons and any dead members are due to the natural process of decay. Eva Mameli (1920, 4) has arrived at the same conclusion as a result of her study of the thallus. She found occasional dead algae but these were chiefly in the deeper layers where light is scanty, and in purely algal colonies such dead members are equally present. The possibility of the fungal haustoria piercing the algal cell is not ruled out, but it happens so rarely, that it is impossible to regard parasitism as a necessary condition. Bachmann (1922) in further work on calcareous endolithic lichens finds in nearly all of those examined that the gonidia, *Scytonema* or *Trentepohlia*, live side by side with the hyphae. The *Scytonema* filaments (in *Petractis clausa*) are surrounded by small-celled hyphae which are in contact but never penetrate. Certain free filaments travel deeply into the rock, and there die off more quickly than those closely associated with hyphae.

In the lime lichens associated with *Trentepohlia* there is also contact without penetration, and free wandering gonidia are frequent; in those associated with *Protococcaceae* there is a well-marked zone of gonidia and in certain species occur wandering members unconnected with hyphae.

He found, however, true parasitism in the thallus of *Arthopyrenia tichothecioides*: the gonidia (*Gloeocapsa* sect. *Xanthocapsa*) form a poorly developed layer towards the surface of the thallus; no wanderers occur in the deeper tissue. The hyphae form a circle round the algal cells which is never quite complete; the swollen ends of the hyphae act as haustoria and destroy some of the algae. This unusual and peculiar habit of growth has induced him to place the species in a new genus, *Xanthopyrenia*. It may also be noted that a blue-green gonidium in *Arthopyrenia* is exceptional.

Bioret (1921) also noted a case of parasitism in the thallus of *Opegrapha herpetica* which has very large gonidial cells (*Trentepohlia*). In several instances he observed penetration of these gonidia by haustoria of the hyphae—the only instances recorded of parasitism in Graphidaceae. Bioret evidently found parasitized gonidia in only one individual of the species.

An undoubted case of parasitism is brought forward by Goebel (1915). He describes a species of *Ephebe* from an aqueous habitat in Brazil. The alga—*Stigonema*—was destroyed by the penetrating haustoria of the fungus hyphae, more particularly in the centre of the thallus. The gonidia towards the periphery were less seriously attacked, and those at the growing tips were practically undamaged. This parasitic condition is not characteristic of our native Ephebes which inhabit a more or less dry substratum.

McWhorter (1921) adduces as proof of the parasitic nature of lichens—or more particularly of lichen hyphae—the cases he has observed in which mosses are destroyed by lichens—*Cladoniae, Physciae, Amphiloma* etc. The destruction was partly due to parasitism and partly to smothering. He thus finds confirmed Bruce Fink's definition: "a lichen is a fungus which lives during all or part of its life in parasitic relation with an algal host and also sustains a relation with an organic or inorganic substratum." His work however proves nothing in regard to the algal host, though the relation to the organic substratum is evidently that of a marauder.

M. and Madame Moreau (1921) have their own views as to the problem of symbiosis: they look on the lichen—the fungal part—as a gall-structure due to the exciting action of the alga. They have studied the occurrence of cephalodia in *Solorina* and find in their structure new proof of the gall-theory. All the

species of *Solorina* contain cephalodia; that is an associated alga other than the normal gonidium. The intruding alga *Nostoc* sp. often becomes surrounded by the *Solorina* hyphae and a tubercle or cephalodium is formed which is referred to by the Moreaus as undoubted gall-structure.

We understand by gall-structure an abnormal development of the plant affected, and due to the irritation of insect or fungus. It is as far as we know a purely vegetative development which never bears fruit, though the parasite causing the gall reproduces freely. In the lichen thallus each symbiont fruits after its kind, and the fungus—the gall plant according to the Moreaus—fails to develop at all without the alga.

A very curious instance of symbiosis between two fungi is described by Vainio (1921) as *Mycosymbiosis*. The association was discovered on the leaves of a tree from the Philippines. The first fungus to arrive, *Gonidiomyces sociabilis* gen. and sp. nov., somewhat resembles a *Capnodium*: it has stoutish branching septate mycelium of a dark brown colour: no fruits were found on it though presumably it is a member of the Pyrenomycetes. The second fungus, *Diplothrix mirabilis*, also new to science, has a fine gray mycelium. It lives on the hyphae of *Gonidiomyces* encircling them and finally producing *Peziza*-like apothecia. Neither fungus suffers from the association, though possibly *Diplothrix* gains most. The resultant growth resembles in form the lichen *Strigula*, also an epiphyte on leaves.

MORPHOLOGY.

A number of workers have selected certain groups and genera for detailed examination. Zanfrognini (1917) in a paper on the lichens of Somalia has added to the systematic description of the lichens an account of the structure of cortex and medulla in several species of *Ramalina* and *Usnea*. Shirley (1919) also approaches systematy by way of histological research. He has given much attention to the families Parmeliaceae and Stictaceae, studying cortices, rhizoids and more especially the pores that he finds present in the thalli; these latter occur in abundance, he finds, all over the thallus of *P. tiliacea*, minute openings difficult to see. In *Parmelia limbata* he has traced the pores or channels from just above the rhizoids to the upper surface where they show as shallow closed pits. He holds that these pores along with the cyphellae and other openings in the thallus of Stictaceae are not only for service in aeration, but allow water and food to be absorbed into the tissues. Shirley forgets the ready absorption of water by the thalline cortex, which water may or may not be charged with mineral salts. Relying on his interpretation of these structures, he would unite under Par-

meliaceae as Section 1: *Parmelia, Sticta* (comprising also *Lobaria* and *Ricasolia*) and *Stictina,* and as Section 2: *Physcia, Anaptychia* and *Anzia.* Why *Anzia* is placed along with *Physcia* he does not explain.

Moreau (1921) also attacks the problem of classification according to thalline form in Stictaceae. He has examined the thallus of seven different species of *Sticta, Stictina, Lobaria, Lobarina* and *Ricasolia* and would unite all these genera under *Sticta.* He finds in the development of the cephalodia a new proof of the phenomenon of biomorphogenesis, that is, in his view, the parasitism of the alga on the fungus, or a symbiosis that excites the fungus to unnatural growth.

A curious morphological development is noted by Zahlbruckner (1921); he records an upright branching *Caloplaca* from S.W. Africa: it had the outward form of *Teloschistes,* but without a cortical layer. Bouly de Lesdain (1921) describes a new genus of Pyrenolichens *Henrica* with rosulate thallus from which podetia-like structures are produced. The plant was found by Abbé Henry on schistose rocks in Italy.

There have been published elaborate papers by Bachmann (1918 and 1922) which continue his work on endolithic lichens. He takes up calcicolous forms associated with *Trentepohlia, Xanthocapsa* and *Scytonema* (see also p. 194). Among the principal points in the paper, we note the description of an epinecral layer of dead hyphae and gonidia over the surface of the thallus of a number of species and above that layer in certain species a cap of slender living hyphae. He found also in the deeper layers of some species clumps of hyphae which he designates as "tubercles." There is great variation in respect of the position of the gonidial zone, but in most thalli solitary algal filaments penetrate more or less deeply into the rock unattached to hyphae. In other species similar filaments protrude from the surface of the thallus and live in the open. In most of the species associated with *Trentepohlia* oil-bearing hyphae or sphaeroid cells were present.

Other forms of embedded lichens have been investigated by E. J. Fry (1922) in connection with the study of the pioneer cryptogamic vegetation of the limestones of Great Orme and S.E. Anglesea. She immersed chips of the rock in acid until the limestone was thoroughly dissolved; the thallus was then washed and prepared for microtome sections. She notes the differences in the cortical zone, the spacing of gonidia and hyphae, the character of the rhizoidal hyphae and above all the occurrence and form of oil cells (see p. 199). They were present in all the lichens examined (*Verrucaria calciseda, Lecidea immersa, Placodium rupestre* var. *calvum* f. *incrustans, Aspicilia calcarea* and

two others indeterminable) as swollen tips of the hyphae, as clusters of sphaeroid cells, as solitary inflated filaments or in strands of hyphae. These oil cells were more abundant in the quicker growing species and in regions of special growth.

In his paper on Graphidaceae, Bioret (1921) finds that the elliptic contour of the thallus in numerous species depends on the form of the bark cells of the host tree, as these elongate transversely so does the thallus of the lichen. The thallus varies considerably in the different genera and species, according to the bark substratum on or within which they subsist. Heredity is manifested mainly in the character of the lirellae.

CYTOLOGY.

There is little to add to our knowledge of cytology. Moreau (1921) in his examination of Stictaceae found that the ascogonium was a complex of uninucleate cells. Trichogynes were formed and reached the surface of the thallus, but degenerated without any copulation with spermatia. The ascogonium itself may become a plectenchyma; the asci and the paraphyses arise from the ascogonial cells.

Bioret (1921) notes in his account of the asci and spores of Graphidaceae that the length of the spores is proportional to the length of the asci which in turn are proportioned by the depth of the apothecia. The spores in several genera are distinguished by transverse septation into a varying number of cells; in those of the type of *Graphis dendritica* there are six or seven septa, division taking place first at the centre. After the first division, a second takes place in each cell close to the median septum, the inner cell does not divide again, but the process is repeated in the terminal cells. The outermost cell alone retaining the power of septation. He also notes that in Graphidaceae as in many other lichens the fruit continues to form asci and spores for many years, though he does not find that sporulation is continuous. The cell division in polarilocular spores is discussed by Mameli (1920, 3). She found in *Caloplaca aurantiaca* var. *polycarpa* many spores distinctly divided by a septum, and the septum was evident along with the channel of union between the polar cells; in other spores the channel tended to disappear. It is satisfactory to note the confirmation of septation in these spores. She also draws attention to the reaction of the apothecial tissues with potash: the tips of the paraphyses and in some cases the contents of the spore alone are stained crimson.

PHYSIOLOGY.

A study of nutritive salts in the lichen thallus was made by Salomon (1914) and of the exchange of substances between algae

and hyphae. He tested over 100 species from various groups and has determined in them inorganic salts of phosphorus, magnesium, calcium, and nitrogen (ammonium salts with nitrites and nitrates). The first four were found in both symbionts; nitrites and nitrates were difficult to locate and are probably used up as soon as they are formed; phosphorus was more abundant in the hyphae than in the gonidia; phosphoric salts as small granules, and crystals of magnesium were found in the apothecia, or more rarely in the thallus.

Mameli (1920, 1) tested for the presence of starch in lichens, and found it—as we should expect—in or close to the gonidia. Starch is a constituent of the green cells alone and can hardly be considered as a product of the symbiotic plant. Glycogen (1920, 5) she found in the gelatinous substance of the cyanophyaceous algae, it also is the product of one symbiont (see West's "Algae," p. 14). Amyloid determined by Moreau in the hymenial tissues has been proved by her to be an insoluble substance.

Bioret (1921) noted in the apothecia of *Graphis* sp. large quantities of minute refractive bodies distributed through the hymenial tissues. He concluded finally that these were oil-drops, and suggests that their function may be to preserve the hymenium from excessive desiccation.

E. J. Fry (1922) discusses the significance of oil in limestone endolithic lichens. She concludes that: "there is probably some relation between growth, evolution of carbon dioxide, oil formation, and solution of the limestone." She agrees with other workers that the oil is not a storage of reserve food but is waste material produced under adverse conditions during the evolution of carbon dioxide. She finds further that the boring action of the lichens is brought about by the carbon dioxide of respiration dissolved in water.

Ethel Mellor (1921 and 1922) has described the action of lichens on glass, and finds as did Gaston Buchet that they may seriously damage church windows. She has identified from the windows 22 lichens, one of which with its variety (*Caloplaca vitricola* and var. *violacea*) is new to science. The conclusions she comes to are:—The immediate cause of corrosion of the glass is the mechanical action of the lichens on glass which has already been chemically altered by moisture, glass having an affinity for humidity in which carbon dioxide from the air is dissolved; the silicates become more or less hydrolysed, with formation of silicic acid and hydrates of calcium and sodium; the lichen hastens the alteration that had already commenced, burrowing into the glass and excavating small flakes. The glass coloured yellow resists corrosion a long time.

Bachmann (1922) has published a paper on the physiological aspects of the lichen thallus immersed in limestone. He considers that water supply is the chief advantage gained by the plant. He tested the rate of absorption for limestone containing—or free from—lichens, and he found that limestone harbouring lichens had a greater capacity of absorption and retained the moisture longer than the lichen-free rock.

Comparing lime lichens with each other he found that those associated with *Pleurococcus* gonidia showed less capacity of water absorption than those with *Trentepohlia*. In the latter case the stone is more deeply pierced by the wandering filaments of the alga. He contrasted silicicolous lichens with calcicolous and found that the latter had the greater capacity of absorption.

Considerable use is made of reagents by systematic workers, notably by Zanfrognini (1917) in his work on Somali lichens. Bachmann (1922) found methyl-green in acetic acid of value as a colour reagent: it stained the hyphae of fungi parasitic on lichens, while the lichen hyphae themselves were unaffected. It would be interesting to see the test applied to the group of half-lichens that are mid-way between lichens and fungal parasites.

During the war, there arose in all countries the necessity to utilize every kind of food supply. Hesse (1915), well known for his researches on the chemistry of lichens, turned his attention to their economic properties. He worked out a comparison of their sugar content with that of potatoes and found that for *Cetraria islandica* the proportion was 1 : 3·35; for *Cladonia rangiferina*, the reindeer-moss, 1 : 2·5. Both of these lichens therefore might be used with advantage as food for man, if the acid products were eliminated. Jacobj (1916) in a pamphlet also encouraged the use of lichens as food stuffs. He mixed reindeer-moss with the food of young pigs with the result that the animals throve better than with ordinary food alone. Rabbits and hares were fed with *Evernia prunastri* after extraction of the acids and the results were also satisfactory.

Bernt Lynge (1921) draws attention to the value of *Cetraria islandica* as a food supply and to *Cladonia alpestris* as a fodder plant; as such the latter is largely employed by farmers in countries bordering on arctic regions.

BIONOMICS.

Under bionomics we touch on many sides of lichen development. Sántha (1916) tested sections of lichens of the genus *Physcia* with polarized light. In most species the upper cortex was clear, the other tissues were more variable as regards the transmission of light and in one group which he designates

obscure the sections were wholly dark. The differences were so constant as to be of specific importance.

Nienburg (1919) has attacked the debated subject of the rate of lichen increase in size. He watched lichen sporlings in nature for a number of years and found that light was more favourable to growth than shade, which suggests that the hyphae respond to increase of gonidia. Taking *Parmelia furfuracea* he figures after one year's growth minute lobes which in three years had reached a length of 1·75 mm. in the shade and about 7·25 mm. in full light. Finally after eight years the maximum size attained was about 22 mm. × 35 mm. These observations agree fairly well with the rate of growth previously observed in foliose lichens, though some other types of lichens increase at a more rapid rate. During the same research he also established definitely that lichens are phototropic: that they grow towards the light and even manage to orient their surfaces so as to gain the fullest amount of sunlight though in this respect lichens are not all equally affected.

Strato (1921) made a series of observations on growth and regeneration in the thallus of *Peltigera canina*, and he comments also on the importance of light. As light is a necessity for the life of the gonidia, so it is one of the essentials of thallus regeneration. Growth in the thallus of *Peltigera* takes place at the circumference; isidia as outgrowths from the thallus are in respect of increase terminal bodies: when the thallus is injured isidia are frequently formed, being induced by the urgent growth of the algae. The cortex of the thallus is covered with felted hair and is not able alone to initiate new growth. Moisture as well as light is an essential of growth and the portions of the thallus under experiment would not "regenerate" under a moist bell glass unless on a substratum of earth or moist clay.

Tobler (1921) draws attention to the few lichens now found growing in the Wolbeck Zoological Garden in Westphalia compared with the large number that were recorded (1856–85). He suggests as a reason for the decrease that lichens are very sensitive to change of environment, and chief among the changes that have taken place is the increase of moisture to a degree unfavourable to their growth. The trees in the enclosure have increased, some of them have been felled, and the lichens meanwhile have decreased.

ECOLOGY.

A number of important papers have appeared on some aspect or other of lichen habitats and lichen ecology. One of the most interesting of these is on "Nitrophilous Lichens" by Sernander (1912). The influence on certain lichens of an abundant supply of nitrogen has long been recognized, but Sernander is the first

to have put the matter to the proof. He recognizes two types of such lichens: (1) ornithocoprophilous and (2) coniophilous. The first mentioned lichens occur on rocks by the sea frequented by birds. A sketch is given of the succession of vegetation. On the summit and on the more level parts of the rocks the alga, *Prasiola*, appears first, followed by lichens such as *Rhizocarpon* spp. To *Rhizocarpon* succeed *Lecanora cinerea* and *Parmelia saxatilis*, the *cinerea-saxatilis* formation largely usurping the place of previous growths. The steep rock-faces are occupied by *Parmelia fuliginosa* and the base by *Bacidia inundata*.

If the rocks are frequented by birds the *cinerea-saxatilis* formation is accompanied or replaced by a *Lecanora saxicola* formation, feebly coprophilous, and by *Physcia stellaris* var. *ascendens*, strongly coprophilous, these two formations including also species of *Caloplaca* (*Placodium*) (*vitellina, cerina, ferruginea*), and by a third formation, *Ramalina polymorpha-Xanthoria lychnea* also strongly coprophilous, on more strongly wind-swept areas than the others. To test these lichens Sernander watered them every evening for a month with a concentrated solution of crow excreta. At the end of the time most of the *Parmeliae, Lecanorae* etc. were unhealthy or dead, while *Lecanora saxicola, Caloplaca* spp. and *Xanthoria* spp. were in good condition.

Comparing tree lichens with those, he found that on frequented roads, where dung laden dust was abundant, the lichens that flourished best were *Physcia ascendens, Ph. ciliaris, Xanthoria lychnea* and *X. parietina*, which he classifies as "coniophilous" species. He gives a further list of those he considers as hemi-nitrophilous.

Nienburg (1919) confirms Sernander's results, he adds *Ramalina fraxinea* as also coniophilous. He found nitrophilous lichens on trees that have wounds on the trunk in which ammoniacal substances are developed, and these when diluted by rain stream down the trunk killing all the lichens in their course except the nitrophilous species. Galløe (1920), in his account of Iceland lichens, rather objects to "nitrophilous," "halophilous" etc. as names for associations owing to the difficulty of determining the dividing line, all lichens being, he says, nitrophilous to some degree. Galløe prefers for associations the terms crustaceous, foliose, and fruticose, with formations named after the dominant forms. Tree lichens were rare in Iceland, rock lichens abundant.

Savicz (1913) in a paper on the lichens of Pskov gives a description of turf moors on which he recognizes three lichen formations: (1) a *Sphagnum* formation with *Cladonia rangiferina, Cl. sylvatica* and *Cl. alpestris* (these compete with the *Sphagnum* and grow to large dimensions); (2) a shrub formation with

Parmelia ambigua, Cetraria saepincola etc. and (3) finally a tree formation (pines) with *Parmeliae, Everniae, Usneae* etc. and with *Lecanora coilocarpa* on all the small branches.

There is still another paper from these northern climes: Du Rietz (1921) has published an important contribution to general ecology with a special section on lichens. He makes much use of the term "constant." In order to determine the "constants" of any given associations, these were divided up into areas, and the plants determined for each area. Only a limited number of species appeared in each area, but as a result of the tabulation it was found that each association presented a characteristic basis of "constants" or dominant species. On these lines he describes various associations either of mixed vegetation such as the *Pinus silvestris-Calluna vulgaris*-Lichen ass. in which *Cladonia rangiferina* and *Cl. sylvatica* are constants, the former being the dominant species; or again a *licheno-nanolignosa* or *Empetrum nigrum-Stereocaulon paschale* association with *Stereocaulon* as a constant. Other associations include only lichens or lichens and mosses, as for instance a *Parmelia omphalodes* ass. which consists of two mosses and about sixty different lichens, widely represented on Scandinavian sea-coasts on the vertical faces of the rocks. It is impossible to do more than indicate the character of Du Rietz's work; the results are given in tabulated form with the numbers and percentages of the species in the different associations.

Going to more distant lands we learn from Shirley (1919) that in Australia *Parmeliae* inhabit stones, rocks, fences and trees in situations where there are strong contrasts of temperature and rainfall. Also that *Stictae*, so abundant in the southern hemisphere, are to be found in scrubs and on bushes where shade and rain are plentiful.

Plitt (1921), after collecting in Jamaica, concludes that "lichens are rather the children of light than the children of moisture; they are found on the dry barren hillsides, in the intensest sunlight, but rarely in the deeper shadow of the moist jungles." The competition for place between the different forms of vegetation is very keen, but lichens, he found, held their own in the struggle. Plitt very definitely indicates associations as for instance in his account of those that favour special trees: on a rose-bush he found *Usnea florida, U. hirta, Lecanora varia, L. subfusca, Ramalina* sp., *Parmelia* sp., *Lecidea* sp., *Graphis* sp., *Pertusaria* sp., *Collema* sp. and *Haematomma puniceum*. He found marked differences between the lichens on Junipers and those on *Cryptomeria* and he notes that though bamboos were singularly free from lichens, yet on nearly all of them grew *Opegrapha filicina*.

ORIGIN AND DEVELOPMENT.

A brief account of Dr Church's views on the origin of lichens from skinned sea-weeds was given in an Appendix to Lichens (1921). Since then several other weighty papers packed with facts and with reasoning have appeared: it is not possible to do more than indicate the trend of his argument. He thus summarizes the stages from stranded alga to heterotrophic fungus-lichens.

"(1) The alga accustomed to a moving aqueous environment finds itself in standing pools of sea-water, and the failure of oxygen-supply is the most readily conceivable cause of the death of the autotropic surface tissues thus leaving the thallus penetrable (a skinned alga).

(2) Competition for substratum gave the mantle of green intrusive gonidia of the type of *Chlorella*.

(3) The associated plants in subsaturated air obtained more oxygen and grew more freely.

(4) The nitrogen-problem still keeps the plants impoverished.

(5) The water-problem tends to keep them small and restricted to short seasonal periods, thus further delaying the rate of growth."

Again: "Lichens of to-day constitute one of the pioneer races of the older world, on the first rock-surfaces exposed above the retreating sea; and they have held their station to the present time, since no other plant organism can compete with them in endurance on such a feeble food-supply."

In the lichen life-cycle, he traces the parallel history of the origin of the mechanisms of the reproductive organization which are always considered to represent racial continuity. He finds that spermatogamy (fertilization by a sperm or spermatium), now vague for the Ascomycetes as a whole, is undoubtedly the dominant method for Lichen-Fungi, as it is also a biological process for securing cross-fertilization, and is undoubtedly of strictly marine origin. Church contrasts this with the still operative fertilization of the Rhodophyceae. He considers fungi and lichens as relics of a very old race and that "in Ascomycetes, lichen fungi and Laboulbeniaceae may be traced such suggestion of Pre-Floridean or Para-Phaeophycean phyla." "It is the quiet pool that is now the characteristic habitat of Florideae and all spermatogamic races must have passed through the same environment."

These few quotations give merely the barest outline. There is much with which one is in agreement, but much also that one does not accept. For instance he considers the Floridean carpospore as homologous with the ascospore as both are produced in closed bodies. There we entirely disagree, and

there are other statements that seem to us wide of the mark, but his view has to be considered by all future lichenologists and I may also add by mycologists, as he traces the origin of all fungi to stranded and skinned algae.

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PARASITES OF SCALE-INSECT FUNGI.

With 3 Text-figures.

By T. Petch, B.A., B.Sc.

In the paper on "Fungi parasitic on scale insects" (Trans. Brit. Myc. Soc. vii (1921), pp. 18–40) it was noted (p. 33) that a black pycnidial fungus with small, brown, narrow-oval spores was found on scale insects in Ceylon, and reference was made to Parkin's suggestion, with which the writer was inclined to agree, that it might be a pycnidial stage of *Myriangium*. A subsequent

study of the genus *Myriangium* has made that suggestion appear improbable, but in the meantime it has been found that H. and P. Sydow had provided a place in systematic mycology for the fungus by instituting the genus *Sirosphaera* (Philippine Journal of Science, VIII C, p. 502, 1913, text-fig. 6).

SIROSPHAERA.

The genus *Sirosphaera* (*Sphaeropsideae*) has globose-conoid, black, subcarbonaceous perithecia, minutely ostiolate, parenchymatous, crowded on a superficial stroma which is composed of rather loose, dark brown hyphae. The basidia are simple, filiform, and hyaline, and bear very minute, continuous, pale brown spores in chains.

The type species, *Sirosphaera botryosa* Syd., was found on living leaves of *Streblus asper* in the Philippines. It forms, *fide* Sydow, a small superficial stroma, composed of dark brown, rather loosely interwoven hyphae, on which the pycnidia are situated, either superficially or with their bases slightly immersed in the stroma, the wall of the pycnidium being easily distinguished from the tissue of the stroma. The wall is parenchymatous and consists of two strata, an outer, several layers thick, brown in colour, with cells 8–10 μ diameter, and an inner one, which is hyaline and composed of minute cells. The whole of the pycnidial cavity is lined with basidia 8–11 μ long, 0·8–1 μ diameter, and the spores are pale brown, 2–2·5 × 1·5 μ.

Sirosphaera botryosa has been collected in Ceylon on *Memecylon*. In the latter case, however, it was not parasitic on the *Memecylon*, but on the fungus, *Pseudomicrocera Henningsii*, which in turn was parasitic on a scale insect, *Aonidia* sp. The pycnidia in this collection were oval or globose, up to 0·2 mm. diameter, black, rugose, sometimes slightly tomentose. The stroma in section was greenish-black. The spores were brown, oval, 2·5–3·5 × 2–2·5 μ. The basidia observed were not more than 3 μ high, and here and there the chains of spores arose from the pycnidium wall. In spite of the latter differences, this gathering would appear to be identical with Sydow's species.

Another gathering of this species has been noted in herbarium collections, viz. the Javan specimen issued by von Höhnel as *Myriangium Duriaei* Mont., on *Erythrina*, Buitenzorg, 1907–8. This in Herb. Kew contains effete *Myriangium* stromata bearing the pycnidia of the parasite. The latter are 0·1–0·2 mm. diameter, with brown spores, either oval, 3 × 2 μ, or globose, 2 μ diameter.

In these last two collections, the hyphae of the *Sirosphaera* penetrate into the host fungus, and the apparent stroma is the original stroma of the host permeated by the hyphae of the parasite.

Another species of *Sirosphaera* has been collected on two occasions in Ceylon, in both instances parasitic on a purple-red or purple-brown stroma which is common in Ceylon on the insects, *Aleyrodes* spp., but which it has not yet been possible to assign to any group. One of these collections, from Hakgala, 5600 ft., is on *Pavetta indica*, and the other, from Peradeniya, 1600 ft., on *Streblus asper*.

In this species, the pycnidia are up to 0·35 mm. diameter, globose, ovoid, or conoid, sometimes turbinate, rugose, at first pruinose, sometimes densely, with minute green particles, and bearing scattered erect hairs, finally becoming black and glabrous, clustered on a black stroma which ultimately covers the purple-brown stroma of the host. Each pycnidium is elevated on a base of stromatic tissue which is greenish-yellow internally. The wall of the pycnidium is thick, parenchymatous, blackish-brown in section with a hyaline inner layer. The ostiola are circular, about 50 μ diameter, not elevated, fringed with yellow or greenish yellow hairs. The green granules consist of irregular hyphae, 4–6 μ diameter, pale greenish yellow by transmitted light, rough, closely septate, sometimes moniliform, sometimes ending in inflated tips or in spore-like spherical bodies up to 8 μ diameter; these hyphae arise from the wall of the pycnidium. The scattered hairs are rigid, up to 44 μ high, 6 μ diameter below, tapering upwards, thick-walled, sometimes nodular, obtuse at the apex. The basidia are simple, 3–9 μ high, but sometimes the chain of spores arises from a short sterigma on a projecting cell of the pycnidial wall. The spores are oval, 2·5–3 × 1·5 μ, or globose, 1·5 μ diameter, pale-brown, sometimes with a clear band across the middle.

This species may be known as *Sirosphaera chlorostoma*. The purple-brown stroma of the host fungus is permeated by the hyphae of the *Sirosphaera* and is blackened internally. In cases where the pycnidia are situated on part only of the host fungus, the remainder retaining its purple-brown colour, the apparently normal part of the host stroma is usually permeated by the parasite, except for a thin cortical zone.

The specimens of *Sirosphaera* which have come under my notice have in all cases been parasitic on entomogenous fungi, i.e. on fungi parasitic on scale insects (including *Aleyrodidae*). It would seem probable, from the description of the type as "quite superficial," that it also was parasitic on an entomogenous fungus.

SIROSPERMA.

Another similar fungus has been described by the same authors (Engler's Bot. Jahrb. LIV (1916), p. 258, fig. 2) as the type of another new genus, *Sirosperma*. It was collected in

New Guinea, parasitic on a *Hypocrella* on *Imperata*. *Hypocrella* is a genus of entomogenous fungi. Professor H. Sydow has kindly furnished me with a specimen from the type collection, which agrees completely with the published description.

The genus *Sirosperma* has black, subcarbonaceous, globose pycnidia, indistinctly ostiolate, superficial, on a subiculum consisting of fuscous hyphae. The spores are minute, ellipsoid, continuous, hyaline, produced in chains from the pycnidial wall, without any basidia. It is said to be near *Sirococcus*, but to differ from the latter genus in the presence of a subiculum and the absence of basidia.

The type species, *Sirosperma Hypocrellae*, has very minute pycnidia, 70–100 μ diameter, crowded together on the surface of the host stroma. Its hyphae overrun the latter and penetrate into it. On the surface of the *Hypocrella* the hyphae are closely septate, with unequally broad segments, like the hyphae of a *Dematium*; within the stroma they are more regular and the segments are longer. The pycnidia have a parenchymatous wall, and are fleshy, not carbonaceous. The spores measure 2–3 × 1·5 μ.

Sirosperma differs from *Sirosphaera* in lacking basidia and having hyaline spores. In both genera the persistence of the spores in chains in the pycnidium is remarkable. Even in free-hand sections they retain their position. On staining with methyl violet it is found that the chains are embedded in a hyaline amorphous substance. This substance is not visible in unstained sections, but it stains blue with methyl violet.

In February 1921, I collected a pycnidial fungus at Hunstanton (England). on *Lepidosaphes ulmi* on Hawthorn, the insect having been previously attacked by *Cephalosporium* sp. The material is not in very good condition, but the fungus appears to be referable to *Sirosperma*. The pycnidia are black, globose, obscurely ostiolate, up to 80 μ diameter, scattered over the scale but chiefly along the edge. The wall is rather thick, but the outer layers are more or less disorganised and overlie a thin, brown, parenchymatous layer consisting of polygonal cells, 3–6 μ broad. The spores are hyaline, oval, 1·5–2 × 1 μ, produced in chains. The mycelium of the fungus consists of brown irregular hyphae, 3 μ diameter, closely septate, with abrupt angular bends, sometimes united here and there into thin sheets by lateral fusion. I name this species *Sirosperma sparsum*. In the present instance, it is parasitic on *Cephalosporium* sp. on *Lepidosaphes ulmi*.

BYSSOSTILBE.

In the Fungi of Ceylon, No. 1003 (Journ. Linn. Soc. XIV, 1875, p. 113), Berkeley and Broome described a species as

Hypomyces stilbiger. Its spores were said to be multiseptate and its conidial stage to be stilbiform. As regards the latter character it would not be unique among *Hypomyces* in Ceylon, since *Hypomyces flavolanatus* Petch has a *Stilbum* conidial stage. Its ascospores, however, are decidedly different from those of a *Hypomyces*; on referring to Berkeley and Broome's illustration (*loc. cit.* Pl. V, fig. 26) it will be seen that they figure a long septate spore which divides up into disc-like part-spores, like a rouleau of coins. Actually, the ascospores are filiform, as long as the ascus, and divide into part-spores only as long as broad, the part-spores finally rounding off and becoming spherical spores which retain their original position in lines in the ascus for a considerable time.

Saccardo transferred *Hypomyces stilbiger* to *Berkelella* from the description. As examination of the type showed that it could not be included in that genus, a new genus, *Byssostilbe*, was instituted for it in Ann. Perad. v, p. 296. *Byssostilbe*, in its perithecial stage, is a *Torrubiella* in which the part-spores are as broad as they are long.

The type species, *Byssostilbe stilbigera*, is parasitic on various species of *Trichia* and *Hemitrichia* in Ceylon. Its conidial stage is the fungus recorded from Ceylon as *Stilbum tomentosum*. Two other species of *Byssostilbe* have since been found in Ceylon, both parasitic on entomogenous fungi, one on *Torrubiella luteorostrata* Zimm., and the other on *Cordyceps dipterigena* B. and Br. Their conidial stages have not yet been observed.

Byssostilbe fusca Petch, n.sp. Perithecia conoid, apex obtuse or papillate, 0·4 mm. high, 0·25 mm. diameter, blackish-brown, darker above, subtranslucent, glabrous. Asci very long, cylindric, capitate, 6–8 μ diam., eight-spored. Spores filiform, as long as the ascus, dividing into spherical part-spores, 1·25–1·5 μ diameter. On the stroma of *Torrubiella luteorostrata* Zimm. on an Aleyrodid on *Murraya exotica*, Hakgala, Ceylon, April 1917. This species differs from *Byssostilbe stilbigera* in the colour and shape of the perithecia; in the latter species, the perithecia are pale yellow to amber, elongated flask-shaped, up to 0·6 mm. high, 0·2 mm. diam.

Byssostilbe tomentosa Petch, n.sp. Mycelium usually covering the stroma of the host fungus (*Cordyceps*) with a thin compact white film. Perithecia clustered, forming continuous groups on the perithecial or conidial stromata of the host fungus, conoid, 0·45 mm. high, 0·3 mm. diameter, with a dense tomentose coat, 0·05 mm. thick, except at the apex, adherent laterally but readily separable, white; ostiolum conical, yellow, subtranslucent. Asci 4 μ diameter, very long, capitate. Spores filiform, as long as the ascus, 1 μ diameter, dividing into part-spores

1·5–2 μ long. On *Cordyceps dipterigena* on a fly (*Mydaea* sp.), on *Psychotria*, Hakgala, March 1922. The fully rounded part-spores have not been seen in this species, but there does not appear to be any doubt that it belongs to *Byssostilbe*, not *Torrubiella*.

The second species is of interest in showing how nature sometimes lays traps for the systematic mycologist. *Cordyceps dipterigena* is remarkably regular in structure and habit. The

Byssostilbe tomentosa on *Cordyceps dipterigena*.

insect attacked bears, as a rule, three clavae, a pair of ascigerous clavae from the thorax, and a single conidial (or barren) clava from the abdomen. I take the latter to be a conidial clava, but I have not yet detected the conidia on it. When attacked by *Byssostilbe tomentosa*, perithecia are produced on the body of the insect, and in irregular groups over the ascigerous stromata, while on the conidial stroma, a cluster of perithecia encircles the clava, so that it resembles a *Cordyceps* with superficial perithecia. If such a specimen were collected alone, it would almost

certainly be described as a new *Cordyceps*. Fortunately, in the present instance, it was gathered with numerous other specimens of *Cordyceps dipterigena*.

The accompanying figures show normal and parasitised specimens of *Cordyceps dipterigena* respectively. Fig. 1 is the normal fungus with the usual pair of perithecial stromata and the single conidial stroma, viewed from the head of the insect, and magnified four diameters. Fig. 2 is a parasitised specimen, viewed laterally, magnified six diameters; the perithecial stromata of the *Cordyceps* are hidden by the perithecia of the *Byssostilbe*, while the conidial stroma is encircled by a cluster of these perithecia. Fig. 3 is another parasitised specimen, in which external mycelium is almost completely lacking; the heads of the perithecial stromata are densely covered with the perithecia of the *Byssostilbe*, and a third cluster occurs on the insect between them. The stalks of the perithecial stromata in this latter example are short and are not seen in the figure; they do not bear perithecia of the *Byssostilbe*.

THE GENUS CLADOSTERIGMA PAT.

By T. Petch, B.A., B.Sc.

The type species of the genus *Microcera*, *Microcera coccophila* Desm., is parasitic on scale insects. Consequently it is of interest to ascertain whether the other species which have been assigned to that genus have the same habit, or whether they are really cogeneric with the type species. Several of these species have already been reviewed in the "Nectriae parasitic on scale insects" (Trans. Brit. Myc. Soc. VII, pp. 99, 100), but a few were not accessible when that paper was written. One of these in particular, *Microcera Clavariella* Speg., was considered a probable entomogenous fungus, as it was described as occurring on living leaves of *Eugenia*; and in response to my enquiry, Dr C. Spegazzini kindly forwarded me the type and other collections of that species from South America.

Examination of the type specimen showed that its structure differed from that of *Microcera coccophila*, and that it could not be included in *Microcera*. It has basidia covering the entire surface of the synnema, like a *Clavaria*. And on further consideration it was evident that the fungus was identical with *Cladosterigma fusisporum* Pat., originally described as occurring on living leaves of a *Myrtaceae*, from Ecuador.

Spegazzini described *Microcera Clavariella* in Fungi Guaranitici, Pugillus I (ante 1886), as occurring on living leaves of *Eugenia*, but not causing any spot. The sporodochia were simple, cylindrical, minute, 250–500 μ high, 50–80 μ diameter, obtuse at the apex, erect, waxy, viscid, rigid, yellowish or flesh-coloured, glabrous, solitary or in groups up to ten, arising from a lenticular, parenchymatous stroma, 0·5–1 mm. diameter, of the same colour as the sporodochia, embedded in the tissues of the leaf. The basidia covered the whole surface of the sporodochia, and were clavate, obtuse or acute at the apex, appearing covered with short longitudinal ridges, hyaline, monosporous, 10–15 × 3 μ. The conidia were clavate, slightly curved, 3–5 septate, not constricted, hyaline, ends acute, 20–27 × 1·5–2 μ.

I have examined three gatherings of this species *ex* Herb. Spegazzini, viz. the type, No. 3483, Caaguazu, Brazil, January 1882; No. 3787 (F. H. 164), on leaves of *Eugenia*, Paraguay, in the forests, April 1883; and No. 4057, f.g.n. 428, Guarapi, October 1883. The two latter differ from the type in minor details, due to more advanced development.

The genus *Cladosterigma* was instituted by Patouillard in "Champignons de l'Equateur," Bull. Soc. Myc. France, 1892, p. 138, t. XII, fig. 3, the generic description being—Fungi biophili, foliicoli, gelatinosi, clavariaeformes, hymenio basidifero undique vestiti; basidia clavata, sterigmatica; sterigmata brevia apice dendroideoramosa; sporulae hyalinae, simplices.

The type species, *Cladosterigma fusisporum*, had cylindrical caespitose clavae, simple, forked, or variously branched, white, gelatinous, pellucid, 0·5–1 mm. high, arising from a black sclerotium, 0·5–1 mm. diameter, immersed in the leaf in a brown circular spot, the spots being scattered or confluent, 2–8 mm. broad. The basidia were claviform, attenuated below, obtusely rounded above, 10–13 × 6 μ, and the sterigmata 4–6 μ high, "denticulato-ramosa." The conidia were fusiform, elongated, acute at either end, guttulate, 16–20 × 5–6 μ. Some of Patouillard's figures were reproduced in Engler-Prantl's Pflanzenfamilien.

Both species occur on living leaves of *Myrtaceae*, and the synnemata or clavae arise from a compact stroma within the tissue of the leaf, breaking through the epidermis in clusters. The description of *Microcera Clavariella* states that there is no spot on the leaf, while Patouillard described and figured a circular brown spot overlying and surrounding each stroma. This difference appears to be due merely to the age of the fungus. In the type specimen of *Microcera Clavariella* the spots are not evident on one side of the leaf, and minute and pale-brown on the other, but other specimens in Herb. Spegazzini

bear circular brown spots exactly resembling those figured by Patouillard. Similarly, the description of the immersed stroma as concolorous with the synnemata in the one case, and black in the other is also to be attributed to a difference in the stage of development of the specimen examined.

The synnemata may be short and forked towards the apex, or forked at various heights in stag's horn fashion. This is the condition figured by Patouillard. But in many cases branching occurs at the base only, so that the free clavae are long, up to 1 mm. high, and slender, not inflated above; and the cluster has then quite a different appearance, especially as the clavae then become variously curved in drying and resemble, at first sight, extruded tendrils, rather than stilboid synnemata.

The dry clavae are subtranslucent, horny-looking, and brittle. They do not swell up in water, and are probably more correctly described as waxy than as gelatinous. The basidia in the specimens examined were clavate or cylindrico-clavate, and it would appear that either the branched sterigma is evanescent, or that some of the basidia may bear only simple, rather blunt sterigmata.

The chief difference between the two descriptions lies in the characters given for the conidia. *Microcera Clavariella* was said to have septate spores, and the specimens examined showed fusiform or clavate spores, straight or slightly curved, acute at at the tips, 1–3 septate, 15–21 × 2–2·5 μ, appearing rough when stained with iodine. The spores were not abundant. *Cladosterigma fusisporum* was said to have fusiform, continuous spores, but as they were described and figured as multiguttulate, it is probable that they were immature. A more serious difference is the measurement given by Patouillard, viz. 16–20 × 5–6 μ, which indicates a much broader spore than that found in *Microcera Clavariella* by Spegazzini and the writer. Patouillard's figures show a ratio of length to breadth, 11·5 to 2, and 9 to 2·5, but even that is greater than in the available specimens of *Microcera Clavariella*.

However, the identity of habitat and structure of the two species would appear to make it improbable that they are distinct, in spite of the discrepancy of the spore measurements. *Microcera Clavariella* is certainly *Cladosterigma*, and it does not appear to be different from *Cladosterigma fusisporum*. The species must therefore be known as *Cladosterigma Clavariella*, and the genus *Cladosterigma* must be included in *Stilbaceae-Phragmosporae*, not in *Stilbaceae-Amerosporae*.

Three species of the same general structure as *Cladosterigma* have been found in Ceylon, all of them parasitic on insects. They differ, however, from *Cladosterigma* in having simple,

rigid, filiform sterigmata and continuous spores. For these I propose a new genus, *Trichosterigma.*

Trichosterigma gen. nov. *Stilbaceae.* Clavariaeform, covered with spherical, subglobose, or ovate basidia, each bearing an apical, rigid, filiform sterigma; conidia terminal, solitary, hyaline, continuous.

Trichosterigma clavisporum Petch, n.sp. Mycelium covering the insect in a matted glabrous sheet and spreading out in a fimbriate margin over the substratum. Clavae arising from the mycelium, erect, terete, simple, up to 8 mm. high, 0·35 mm. diameter below, tapering upwards, brownish white (dry), smooth. Basidia crowded, ovate, up to 8 μ high, 2–3 μ diameter, rounded or attenuated at the apex. Sterigmata rigid, simple, filiform, 5–9 μ high. Conidia hyaline, continuous, clavate, 4–8 × 1–1·5 μ. On a caterpillar attached to a living leaf, Peradeniya, January 1912.

Trichosterigma arachnophilum Petch, n.sp. Mycelium covering the body of the insect and forming a flattened pulvinate, pale yellow, somewhat spongy, tomentose stroma, with a fimbriate margin. Clavae arising from the stroma, pallid yellow, cylindric, up to 4 mm. high, 0·15 mm. diameter below, tapering slightly upwards, smooth, simple. Basidia scattered or crowded, globose, 3 μ diameter, or subglobose, up to 6 × 5 μ. Sterigmata simple, rigid, about 2 μ long. Conidia narrow-oval, ends acute, continuous, 4–8 × 2 μ. On a spider attached to a living leaf, Hakgala, March 1922; Peradeniya, March 1909; Peradeniya, March 1917. This species is the conidial stage of *Torrubiella flava* Petch. The specimen from Peradeniya, March 1909, differs in colour, being lilac grey. A similar colour difference occurs in *Gibellula elegans* P. Henn., which is also parasitic on spiders.

Trichosterigma attenuatum Petch, n.sp. Mycelium scanty, brownish, overrunning the host insect. Clavae arising from the body or legs of the insect, usually from the joints, or along the margins of the wing covers. Clavae pale brown (dry), up to 6 mm. long, 0·2 mm. diameter below, tapering upwards to 0·08 mm. diameter, rigid, slightly inflated at the apex, terete, smooth, bristling with hyaline sterigmata when magnified. Basidia oval or flask-shaped, 8–10 × 3 μ, attenuated into a rigid simple sterigma, up to 26 μ long, 1·5 μ diameter at the base, tapering upwards. Conidia solitary, hyaline, continuous, oval or lozenge-shaped, usually acute at each end, 6–7 × 3–5 μ. On a Pentatomid on bark, Hakgala, May 1912. The insect in the type specimen bears more than forty clavae, but many of them have been broken.

SOME ADDITIONAL RECORDS OF SURREY RESUPINATE HYMENOMYCETES.

With 8 Text-figures.

By E. M. Wakefield and A. A. Pearson.

The present list contains a larger proportion of Heterobasidiae than were contained in our previous lists, and this group will evidently well repay further attention. The specimens however must be studied soon after gathering, when the hymenial cells are turgid. They soon collapse on drying, and little or no trace of the plant may remain. Some species are of such a delicate colourless nature that their presence is only made manifest to the naked eye by the faintly pruinose appearance of the wood on which they grow. A lens reveals the thin transparent film, and if gathered at a favourable stage of development the microscopic characters are easily detected. Soon after maturity however the hymenial elements are apt to become indistinct, and often only the spores can be found. This especially applies to species of the genus Tulasnella. These have frequently been found in an imperfect condition, and it is probable that many more exist than have been described. The two new species included in the present list are both exceedingly thin and delicate even when at their best, and are easily overlooked.

Corticium bisporum Bourd. et Galz. in Bull. Soc. Myc. Fr. XXVII, 1911, p. 240. ? *Hypochnus bisporus* Schroet., Pilz. Schles. p. 415.

Effused, indeterminate, white to cream, easily separable, very thin. Hymenium forming a continuous pellicle above the loose cottony subiculum, often wrinkled or rather bullate when fresh but becoming quite smooth as it dries. Basidia arising from branched hyphae in a corymbose manner, clavate, 15–25 × 6–7·5 μ; sterigmata constantly 2, short (4–5 μ), divergent. Spores ovate, elliptical or somewhat oblong, hyaline, smooth, 8–11 × 4·5–6 μ. Basal hyphae very loosely interwoven, septate, very rarely with clamp-connections, 4–6 μ in diameter. Rod-shaped crystals present in abundance in the subhymenial tissue.

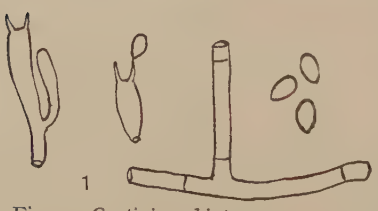


Fig. 1. *Corticium bisporum.* × 550.

On a fallen branch, East Horsley, Jan. 1922, A.A.P.

We are indebted to M. l'Abbé Bourdot for the identification

of this species. The macroscopic appearance is similar to that of *Corticium arachnoideum*, but the characters of spores and basidia differ.

The species as understood thus by Bourdot differs in several details from the original description of *Hypochnus bisporus* by Schroeter, notably in the size of the spores. Schroeter described his species as having spores 5 × 3–3·5 μ, considerably smaller than those of the present species. Further the hyphae of *H. bisporus* were said to have clamp-connections, from which one would infer that they were fairly frequent. In the present form, however, these structures are so rare as to be easily overlooked unless careful search is made.

On the other hand, Schroeter's type specimen apparently no longer exists (cf. von Hoehnel and Litschauer in Ann. Myc. IV, 1906, p. 288), and in the absence of any information as to what it may have been, the name may well be kept for this species, which is characterised by its constantly 2-spored basidia. It should however be cited as above.

Corticium diademiferum Bourd. et Galz. in Bull. Soc. Myc. Fr. XXVII, 1911, p. 244.

Effused, adnate, very thin, whitish to cream, margin indeterminate. Basidia 15–21 × 5–6 μ with 6–8 sterigmata. Spores subglobose, 4–5 × 3–4 μ. Hyphae thin-walled, with clamp-connections, 3–5 μ.

On bark of a birch log, Effingham, Mar. 1921, A.A.P.

The above description is taken from that given by Bourdot and Galzin. The specimen cited was so determined by M. Bourdot, but has spores which are ovate rather than subglobose. The basidia are of the characteristic shape of the group *Urnigera* B. and G.

Fig. 2. *Corticium diademiferum.* × 550.

Fig. 3. *Corticium tulasnelloideum.* × 550.

Corticium tulasnelloideum von Hoehn. et Litsch. in Sitz. K. Akad. Wiss. Wien, Math.-naturwiss. Kl., Bd. CXVII, 1, 1908, p. 1118.

Effused, very thin, closely adnate, appearing as little more than a pruinosity on the surface of the matrix. Hymenium smooth and continuous when best developed. Basidia clavate, 12–20 × 6–8 μ with 2–4 sterigmata, 6–7 μ long. Spores broadly elliptical to subglobose, very finely and closely echinulate,

4·5 × 3 μ or 4 μ in diameter. Hyphae distinguished with difficulty, recorded as 2·5 μ in diameter, with clamp-connections, by Bourdot and Galzin.

On rotten decorticated wood, Mulgrave Woods, Yorkshire, C. Crossland, Oct. 1912; Horsley, Mar. 1921, A.A.P.

This species may be more common than the above two widely separated records would indicate. It is one of the very delicate, easily overlooked forms. The first specimens sent by the late Mr C. Crossland were in excellent condition, as his consignments always were, but the species was not then recorded because it was hoped that further confirmatory specimens would be received. Until the Horsley specimen, however, none has been forthcoming. The Horsley gathering is much more scanty, but the habit and characteristic spores leave no doubt that it is the same species.

The measurements of spores and basidia given above are from the Mulgrave specimen, and agree with those of the type, a fragment of which was kindly communicated by M. Bourdot.

SACCOBLASTIA Moeller, Protobasidiomyceten, 1895, p. 162.

Effused, floccose or gelatinous. Basidia cylindrical, transversely septate, arising from a probasidium which remains as a lateral, sac-like attachment at the base of the basidium. Sterigmata lateral. Spores hyaline, smooth.

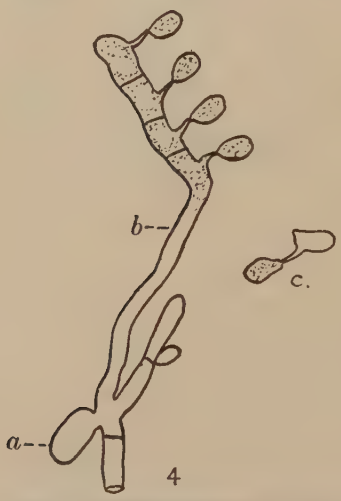


Fig. 4. *Saccoblastia sebacea*. *a*. Probasidium. *b*. Basidium. *c*. Germinating spore. × 550.

Saccoblastia sebacea Bourd. et Galz. in Bull. Soc. Myc. Fr. XXV, 1909, p. 15.

Effused, greyish, thin, fleshy, at first rather firm in texture, later becoming slimy-gelatinous. Hymenium delicately pruinose and somewhat granulose when in good condition, as seen under the lens. Probasidium 15–25 × 7–9 μ, ovoid to oblong, pendulous, collapsing as the basidium matures and often breaking away in the preparation of sections. Basidia cylindrical, curved, 5–8 μ wide above, narrowing gradually to a more or less elongated pedicel below, with 2–3 transverse septa in the upper part. Sterigmata lateral, conical, 8–10 × 2 μ. Spores broadly elliptical, laterally apiculate, smooth,

hyaline, 7–10 × 4·5–7 μ, germinating immediately to produce secondary spores of similar form. Hyphae frequently septate, without clamp-connections, often constricted at the septa, 3–5 μ in diameter; contents, as also those of the probasidium and young basidia, granular and with numerous oil-drops.

On old stumps of beech, birch and oak, Horsley, Feb., Mar. and April, 1922.

In the original description the species is given as "mucoso-gelatinosa" in texture. The excellent series of specimens collected at Horsley showed that this was so only in the later stages. When at its best the fungus has somewhat the consistency of *Corticium confluens*, and is beautifully pruinose with the projecting basidia and spores.

Platygloea Peniophorae Bourd. et Galz in Bull. Soc. Myc. Fr. XXV, 1909, p. 17.

Fungus starting as small patches, then becoming effused over the surface of the host, very thin, whitish to pale buff, margin pure white, somewhat byssoid. Hymenium pruinose under a lens, but interrupted here and there by masses of spores (conidia?) which are aggregated in semi-liquid globules. Basidia curved, transversely 2–3 septate, 5 μ wide. Sterigmata filiform, flexuose, up to 40 μ long. Spores elliptical with one side depressed, and with a pronounced lateral, oblique apiculus, 8–9 × 5–5·5 μ, germinating to form secondary spores of similar size and shape.

Fig. 5. *Platygloea Peniophorae.* × 550.

Growing over the hymenium of *Corticium praetermissum*, and probably also *Peniophora pubera*, Horsley, Mar. 1922, A.A.P.

The fungus as described above from the specimens cited differs in some particulars from the original description. In particular our fungus has not dried "horny and greyish," but as a thin, white, markedly pulverulent film. Nor were any sterigmata found as long as those described by Bourdot and Galzin (90 μ and more). The longest sterigmata found in our specimens were 40 μ long, and these were exceptional. It is probable that both these points of difference are due to the fact that our fungus was younger and therefore less thick than the specimens seen by the authors of the species. It is well known that the length of basidia and of the sterigmata of the Auricularineae varies according to the depth of origin in the tissue.

Tulasnella violacea (Johan Olsen) Juel in Bihang K. Sv. Vet.-Akad. Handl. XXIII, Afd. III, No. 12, 1897, p. 22.

Effused, very thin, deep violet when fresh but drying to pale

lilac. Basidia subglobose to oblong, 12 × 8–11 μ; sterigmata 8–10 × 6–7 μ. Spores subfusiform, curved, 12 × 7 μ. Basal hyphae septate, without clamp-connections, 4–6 μ in diameter.

In a large patch on the bark of an old birch log, Weybridge, Jan. 1922.

The spores of this specimen agree better in size with those of the var. *lilacea* Bres. than with those of the type, which were described as 15 × 8 μ. It seems probable that the species varies both in colour and in spore-size. The shape of the spores is characteristic.

Fig. 6. *Tulasnella violacea.* × 550.

Fig. 7. *Tulasnella allantospora.* × 550.

TULASNELLA ALLANTOSPORA Wakef. et Pears. sp. nov.

Fungus effusus, tenuissimus, ceraceus, hyalinus vel levissime lilacinotinctus. Basidia obovata, 7–10 × 6 μ. Sterigmata elliptica, 7–9 × 5 μ. Sporae cylindraceae, curvulae, utrinque attenuatae, 9–10 × 3–4 μ. Hyphae basales 2–3 μ septatae, non nodosae.

On decorticated coniferous wood, East Horsley, April 1922, A.A.P.

This species forms an exceedingly thin film, scarcely visible to the eye when looked at direct except as a slight dullness of the surface of the wood. When the specimen is tilted so as to catch the light, however, the fungus appears as a delicate "bloom" with a very faint pinkish or lilac tinge. The species is recognisable by its delicacy and the small curved spores.

TULASNELLA MICROSPORA Wakef. et Pears. sp. nov.

Fungus effusus, tenuissimus, pulverulentus, pallide lilacinus. Basidia obovata vel ellipsoidea, 7–10 × 5–6 μ. Sterigmata elliptica, 2·5–3·5 × 2–3 μ. Sporae ovatae, 5·5–6 × 3–3·5 μ. Hyphae basales ramosae, septatae, non nodosae, 2–3 μ diametro.

Fig. 8. *Tulasnella microspora.* × 550.

On rotten coniferous wood, East Horsley, Mar. and April 1922, A.A.P.

The species is probably not uncommon, but it has rarely been found in a condition good enough for description. The colour when dry is very like that of *T. violacea*, but the small size of spores and hyphae is distinctive for *T. microspora*.

The following species are also additional to our previous lists for Surrey:

Corticium caeruleum Fr., *Peniophora subalutacea* (Karst.) v. H. and L., *Odontia stipata* (Fr.) Quél.

THE PRODUCTION OF FRUIT-BODIES OF COPRINUS COMATUS IN LABORATORY CULTURES.

By Irene Mounce, M.A. (British Columbia), Hudson's Bay Company Research Fellow, University of Manitoba.

I. Introduction.

Brefeld, in his Untersuchungen, states that the large fruit-bodies of *Coprinus comatus* and *C. atramentarius* are very easily raised in dung cultures; but, unfortunately, he gives us no details of the method he employed*. Hitherto, no one seems to have confirmed Brefeld's results with these two species. Professor Buller has informed me that he has twice attempted to obtain fruit-bodies of *Coprinus comatus* on sterilised horse-dung balls contained in large crystallising dishes but that, although the mycelium grew well and continued living for many months, in neither of his cultures did fruit-bodies ever appear. Since the fruit-bodies of *Coprinus comatus* are of large size and edible, it seems well worth while to endeavour to elucidate the conditions under which they may be brought into existence.

Coprinus comatus and *C. sterquilinus* appear to be closely related species, for not only do they resemble one another in general form, in the possession of an annulus, and in having a scaly pileus, but their mechanisms for the production and liberation of spores are practically identical†.

Coprinus sterquilinus fruits readily in sterilised horse-dung cultures. Whilst studying the homothallism of this species, I made a large number of such cultures and found that normal fruit-bodies always appeared upon them within 24–31 days from the time the spores were sown‡. The production of fruit-bodies

* O. Brefeld, Untersuchungen, Heft VIII, Autobasidiomyceten, 1889, p. 39.

† A. H. R. Buller, Die Erzeugung und Befreiung der Sporen bei *Coprinus sterquilinus*, Pfeffer-Festschrift, identical with Jahrb. f. wiss. Bot. LVI, 1915, pp. 299–329, Taf. II and III.

‡ I. Mounce, Homothallism and the Production of Fruit-bodies by Monosporous Mycelia in the Genus Coprinus, Trans. Brit. Myc. Soc. VII, 1921, p. 203; also Homothallism and Heterothallism in the Genus Coprinus, ibid. 1922, p. 259.

was not affected by the origin of the mycelium; for the mycelium, whether it originated from one spore only or from many spores, always grew rapidly and produced a fruit-body within a month. Since *Coprinus sterquilinus* fruits so readily in pure horse-dung cultures, it was thought that *C. comatus*—its near relative—might do so too. However, a series of experiments with dung cultures has convinced me that this supposition is erroneous. The fact is that, although *Coprinus comatus* can be caused to fruit in laboratory cultures, the cultures require to be made in a particular manner and, even then, fruit-bodies appear upon them only after the mycelium has been growing for several months.

II. Experiments and Results.

During the autumn of 1920 I made ten cultures of *Coprinus comatus* on large masses of sterilised horse dung contained in crystallising dishes covered with glass plates. One of the cultures was inoculated with spores from a spore-deposit, another with a small piece of a spore-laden gill taken from a fruit-body that was shedding spores, and the remaining eight with a small piece of tissue procured from the inner side of a stipe. As a result of these inoculations a heavy white mycelium was produced which, in the course of 20–28 days, entirely covered the medium in crystallising dishes nine inches in diameter. The mycelium derived from the spores required a few more days to cover the medium than that derived from a stipe, on account of the fact that the spores took some time to germinate while the piece of tissue removed from a stipe produced rapidly growing hyphae immediately. Several of the mycelia developed heavy white cords on the under surface of the medium and one gave rise to woolly knots on the cords; but, although all the ten mycelia grew vigorously, in the end not one of them developed fruit-bodies even of the most rudimentary kind.

Various changes were made in the conditions of cultivation of the fungus in an attempt to accelerate fruit-body production. Some of the mycelia were placed in the dark, one in bright sunlight, and the rest in diffused daylight; but the results were all negative: no fruit-bodies appeared.

Falck* found that fruit-body production in *Merulius domesticus* is accelerated in artificial cultures by a series of transfers, a mycelium which has just covered the medium in one vessel being transferred to a second vessel containing the same medium, and the mycelium which has just covered the medium in this second vessel being transferred to a third vessel, and so

*R. Falck, Die Fruchtkörperbildung der im Hause vorkommenden holzzerstörenden Pilze in Reinkulturen und ihre Bedingungen, Mycologische Untersuchungen und Berichte, 1, 1913, p. 62.

forth. Such a series of transfers I made with a mycelium of *Coprinus comatus*. A stipe-culture was growing on sterilised horse-dung balls contained in a crystallising dish five inches in diameter. As soon as the mycelium had covered the medium, a small piece of mycelium-covered dung was removed and placed in a second similar dung-dish. Four such successive transfers were made and it was found that it took the mycelium 10–11 days to cover the medium in each dish. Although all the four cultures were maintained for months, no fruit-bodies were produced upon them; yet the mycelia were vigorous and, as shown by their abundant clamp-connections, they were all *secondary*, i.e. in that sexual condition which the mycelia of Hymenomycetes normally attain before the development of sporophores takes place*.

Finally, at the suggestion of Professor Buller, deep culture vessels, instead of shallow ones, were employed, and the culture medium was covered with a thick layer of soil. Two such deep cultures were made in the following manner: (1) A specimen jar 11 inches high and 3 inches in diameter was filled to a depth of 3 inches with a layer of horse dung mixed with sawdust. The mixture was packed down and then the jar was filled to within an inch of the top with sifted black soil. The whole was then covered with a glass plate and sterilised in flowing steam for one hour on each of three successive days. After sterilisation had been accomplished, two vertical holes were made through the six-inch layer of soil with a sterilised glass rod, and through these holes small pieces of mycelium-covered dung taken from a stipe-culture were pushed well down into the layer of dung and sawdust below. (2) A three-litre beaker was filled to within three inches of the top with a mixture of horse dung and sawdust resembling that used for the first culture. After being packed down, the mixture was covered with a two-inch layer of sifted black soil. The beaker and its contents were then sterilised and the culture-medium inoculated in the manner already described.

The inoculation of the culture medium in the two vessels was effected on January 7, 1921. After inoculation, both vessels were set on a table near a window in the laboratory and each was covered with a large bell-jar. The loose glass plate resting on the top of each vessel and the enveloping bell-jars served to reduce the rate of evaporation from the surface of the soil to a minimum. Indeed, evaporation took place so slowly that it was found unnecessary to water the cultures during the ten months which elapsed before they fruited.

* Cf. I. Mounce, Homothallism and the Production of Fruit-bodies by Monosporous Mycelia in the Genus Coprinus, Trans. Brit. Myc. Soc. VII, 1921, pp. 198–200.

Within a week after the inoculation of the two vessels, the inoculation holes became filled with dense white mycelium. In the specimen jar, at the end of twenty days, the mycelium had completely covered the surface of the culture medium with fine white silky hyphae; and thin almost invisible hyphae had made their way through the soil on both sides of the holes. In the three-litre beaker, the mycelium grew in a similar manner and, at the end of six weeks, it had completely covered the medium.

A little later, in each culture, woolly knots of mycelium appeared on the mycelial strands that traversed the upper surface of the soil layer, but for a long time no further changes could be observed.

During the summer no fruit-bodies were produced, but toward the end of September, i.e. almost nine months after inoculation, a tiny fruit-body rudiment was observed in the specimen jar coming up at the surface of the soil. The rudiment developed rapidly and, in the course of a few days, became converted into a very large normal fruit-body of *Coprinus comatus*, which elongated its stipe, expanded its pileus, and shed an abundance of spores within a week from the time the rudiment was first noticed. The spores were found to germinate readily in potato agar and fairly well in dung agar.

In the specimen jar, about three weeks after the fruit-body just described had shed its spores, and about ten months after inoculation, many white mycelial knots appeared on the outer cylindrical surface of the soil and a few centimetres below the soil's upper surface. Ten days later three new fruit-bodies, which had originated in tiny crevices beneath the soil's surface, had pushed their way through the soil into the air. They were creamy white in colour, they had a smooth, gelatinous, oily-looking surface, and they were somewhat conical in shape with a base about 5 mm. in diameter. Five days later they were 7 cm. high and each of them was distinctly divided into pileus and stipe. The pilei, which shaded from the cream colour below to a deep buff at their apices, showed signs of becoming scaly, but each had the annulus still attached to its base. After ten days, in each of the three fruit-bodies, the stipe was rapidly elongating, the annulus had become detached from the base of the pileus and had fallen upon the stipe, expansion of the pileus had begun, the gills were passing through shades of red to black, and it was evident that the spores were maturing. During the next two days, the three pilei opened and discharged vast numbers of spores.

In the meanwhile, the second or beaker culture of *Coprinus comatus* had produced a single fruit-body which shed its spores five days before the three fruit-bodies just described. The de-

velopment of this fruit-body was quite normal except that the pileus became somewhat withered in appearance owing to the fact that maggots invaded the culture shortly after the glass cover had been removed to allow the fruit-body to develop without mechanical hindrance. Two weeks after this first fruit-body had shed its spores the mycelium produced three more fruit-bodies. Unfortunately, however, owing to the ravages of the maggots in the culture medium, these three fruit-bodies never fully matured.

From the facts given above it is evident that a total of four fruit-bodies was obtained in each of the two cultures. Thus it has been demonstrated that, under suitable conditions, *Coprinus comatus* can be caused to fruit in a perfectly normal manner in the laboratory.

The beaker culture contained six times as much food material as the jar culture, and yet the two cultures began to fruit within a month of each other, i.e. they were fruiting almost simultaneously. It is also remarkable that, while the two cultures were fruiting in the laboratory, scores of wild fruit-bodies of *Coprinus comatus* were coming up just outside in the botanical garden. These facts suggest that there may be a periodicity in the development of *C. comatus* comparable with that of *C. sterquilinus*. With *C. sterquilinus*, after the sowing of the spores on sterilised horse dung, fruit-bodies are produced at the end of a month with great regularity, always provided that the cultures are kept moist and free from infection. Perhaps with *C. comatus* this necessary period of development is a longer one, occupying some nine or ten months instead of one. Whether or not it is possible to shorten this developmental period can only be decided by further experiment.

III. Summary.

1. Brefeld's statement that *Coprinus comatus* fruits readily in dung cultures has not been verified; for, when grown upon bare horse-dung balls, the mycelium remained sterile.

2. Eight fruit-bodies of *Coprinus comatus* have been obtained in the laboratory by growing a mycelium in the secondary (clamp-connection producing) condition upon a sterilised mixture of horse dung and sawdust buried beneath a thick layer of soil at the bottom of deep culture vessels.

3. The fruit-bodies raised in the laboratory were of large size, were perfectly normal in general appearance, and produced spores which germinated readily.

4. The interval between the inoculation of the culture medium with mycelium and the production of fruit-bodies was from nine to ten months.

The investigation recorded above was carried out in the Botanical Department of the University of Manitoba during my tenure of the Hudson's Bay Company Research Fellowship. In conclusion, I desire to express my sincere thanks to Professor A. H. Reginald Buller for suggesting the investigation and for valuable advice during its progress.

NOTES ON SOME BRITISH PYRENOMYCETES.

By Sir H. C. Hawley.

The following short notes deal with a few fungi collected in the last ten years or so. They do not profess to deal with them exhaustively. Species which are apparently new to the British Isles are indicated by an asterisk. It is hoped that the attention of other members of the British Mycological Society may be drawn to this interesting group. Meanwhile the writer would be grateful for any specimens sent to him.

Sordaria platyspora Phill. and Plowr. in Grev. VI (1877), p. 28, t. 94, f. 2.

This plant was described as having perithecia with short stiff hairs, sessile cylindrical asci, and spores nearly circular, 20 × 18 μ, 2–3 μ thick. It is also recorded from Scotland (Trans. Brit. Myc. Soc. IV (1913), p. 68). In 1912 I found on rabbit dung in Sussex a fungus with similar hairy perithecia, subsessile asci and disciform spores, 20–21 × 16–17 μ, 6 μ thick. I concluded, notwithstanding the thicker spores, that it was the same. On further consulting the literature, I found that Winter had described a form *major* of *S. discospora* Niessl with spores 17 × 14–15 μ. The spores of typical *S. discospora* are given as 12–14 × 10 μ, or according to Traverso (Flor. Ital. Crypt. I, Pyren. (1907), p. 920), 10–14 × 8–11 μ. Phillips and Plowright also described *Sordaria microspora* with similar but still smaller spores. Spore size is very variable in the Sordariaceae, but it seems better for the present to maintain two distinct species, the one with spores 10–14 × 8–10 μ, the other with spores 17–21 × 15–18 μ—the thickness in both varying from 3–6 μ, rather than to follow Traverso in making *S. platyspora* a synonym of *S. discospora*. At the same time there seems no doubt that *Sphaeria scatigena* B. and Br. in Ann. Mag. Nat. Hist., Ser. III, VII (1861), p. 452 (Notices No. 972), (*Hypocopra* Sacc. Syll. I, 243) is the same as *Sordaria platyspora*—which should be regarded as a synonym of *Sordaria scatigena* (B. and Br.).

Neopeckia fulcita (Bucknall) Sacc. *Lasiosphaeria fulcita* Buck. in Proc. Bristol Nat. Soc. v (1887), p. 126.

This occurred at Lytchett Matravers, Dorset, July, 1922, on rotting bark of *Prunus Laurocerasus*. It differed from the Bristol specimens at Kew in being on bark instead of on bare wood, in being almost completely superficial instead of with base immersed and in having more hairy perithecia which had not collapsed in folds. The Lytchett perithecia were indeed very evidently hairy under a hand-lens. No paraphyses were seen but the asci were involved in a diffluent mass. In other respects it agreed exactly. The fungus in some ways suggests *Melanopsamma pomiformis* Sacc. but is hairy and with spores becoming more truly brown. It is probably uncommon.

Lasiosphaeria sulphurella Sacc. in Mich. I (1878), p. 440.

This species was collected in Lincolnshire in 1908. The cell-walls of the perithecia are of a yellowish context, not in any way carbonised. It does not appear common but was recorded from Kew (Grev. XVI (1886), p. 17). It belongs to the section *Leptospora* of *Lasiosphaeria*.

Bertia moriformis (Tode) de Not. in Giorn. Botan. Ital. I (1844), p. 335.

Specimens from Mulgrave Wood, communicated by the late Charles Crossland, otherwise typical, proved to have hyaline spores, at first 1-septate, finally 3–7-septate, 48–52 × 5–6 μ. Some of these spores were seen germinating from every cell. I have examined numberless other specimens but none had spores more than 1-septate. The spores are rather large for the species. I have not found 1-septate spores more than 46 μ long, still they most probably represent the mature state of *Bertia moriformis*. I am not aware that these multiseptate spores have been previously noticed. The matter is worthy of further investigation.

B. collapsa Rommell in Bot. Notiser (1892), p. 178.

This is certainly only a corrugated form of *Melanopsamma pomiformis* Sacc., as an examination of Rommell's specimen at Kew proved. The mature spores are pale brown. Marquand's material from the Channel Islands (Trans. Brit. Myc. Soc. I (1897), p. 24) is the same.

Rosellinia papaverea (B. and Br.) Ces. et de Not. in Comment. Crittogam. Ital. (1863), p. 228. *Sphaeria papaverea* B. and Br. in Ann. Mag. Nat. Hist., Ser. II, VII (1851), p. 188, t. 7, f. 14 (Notices No. 612).

An examination of a Batheaston specimen at Kew showed the perithecia to be $\frac{1}{2}$ mm. across, covered, except the papilla, with a whitish felt (which may be adventitious) and seated on

a purplish-brown subiculum. The asci are 100–110 × 7–8 μ. The brown spores are straight or slightly bent, 10–11 × 5 μ. The ostiola are very remarkable and just as described by Berkeley and Broome. The contents of the perithecia may be seen being ejected through the pores as short tendrils. I am not aware that this species has again been recorded either in this country or abroad.

**Ceratosphaeria rhenana* (Auersw.) Wint. in Rabenhorst's Krypt-Fl. I. 2 (1885), p. 257. *Gnomonia rhenana* Auerswald in Gonn. and Rabenh. Myc. europ. V and VI (1869), p. 23.

Lytchett Matravers, Dorset. Not infrequent.

**Didymosphaeria vexata* (Sacc.) Wint. *l.c.* p. 422. *Didymella vexata* Sacc. in Mich. II (1880), p. 58.

On twigs of *Cornus*, Lytchett Matravers, Dec. 1921. The ovate subsessile asci and septate paraphyses are very noticeable. The epidermis was not perceptibly blackened. It is possible that *D. trivialis* (B. and Br.) Sacc. recorded from Batheaston and on *Cornus* (see Massee, in Grevillea XVIII (1889), p. 11) may prove identical.

Anthostoma amoenum (Nke.) Sacc. Syll. I (1882), p. 307. *Fuckelia amoena* Nke. in Fuckel Symb. Mycol. (1869), p. 224. *A. rhenanum* (Fuck.) Sacc.

Von Höhnel in Ann. Myc. XVI (1918), p. 122, definitely regards this species as synonymous with *A. rhenanum* (Fuck.) Sacc. Schroeter in Krypt-Fl. Schles. III. 2, p. 434, had suspected this. Winter in Rabenhorst's Krypt-Fl. II. p. 760, had described the spores as inaequilateral and bean-shaped, but this seems an error or exceptional and neither Schroeter nor von Höhnel mention it. The spores in my specimen were quite straight, broad and oblong, rather abruptly attenuate towards the ends, more towards the lower end and with the upper provided with a small obtuse hyaline knob. No hyaline envelope was evident all round but the knob is very persistent. It was absent however in some ejected spores. The valsiform nature of the pseudostromata is very evident. The upper surface of the cortex is blackened but no circumscribing black line was seen. It is recorded on *Acer* and *Fagus* by Winter, on *Fagus* by Schroeter and on *Carpinus* by von Höhnel. My specimens were on oak, near Bassenthwaite, Cumberland, Sept. 1922.

**Valsa Pini* (A. and S.) Fr. Summa veg. Scand. (1849), p. 412. *Sphaeria Pini* A. and S. Consp. (1805), p. 20.

On small branches of *Pinus sylvestris*. High Hurstwood, Sussex, February, 1912. Differs from *V. Abietis* Fr. in the more numerous perithecia. The spores were 10–12 × 2–2·5 μ. They are given as 6–9 × 1·5 μ by Winter, *l.c.* p. 709, though Berlese

and Bresadola (Micromyc. Trident. (1889), p. 10) give 10–11 × 2 μ for their forma *divergens*.

**V. horrida* Nke. Pyr. Germ. (1870), p. 176.
On birch poles, Sussex, Dec. 1911.

**V. germanica* Nke. *l.c.* p. 215.
On birch, Sussex, Jan. 1912. Appears to be constantly distinct from *V. ambiens* in its smaller spores 10–15 × 3–4 μ.

V. decorticans Fr. Summa veg. Scand. (1849), p. 412.
On hornbeam, Epping Forest, March 1910. On beech, Keswick, Sept. 1922. The spores of the specimens on hornbeam were only 10 × 2 μ as compared with 10–13 × 2·5 μ on beech, but they appear to belong to one species and to be distinct from any form of *V. ceratophora* Tul.

**Diaporthe Malbranchei* Sacc. in Mich. 1 (1879), p. 509.
On elm, Hove, Sussex, Nov. 1910. Only definitely distinct from *D. Eres* Nke. in its scarcely exserted ostiola.

D. resecans Nke. Pyr. Germ. (1870), p. 314.
Occurred at High Hurstwood, Sussex, both on *Syringa* and *Forsythia*, the two gatherings being quite indistinguishable.

**D. retecta* Fuck. and Nke. in Fung. rhen. No. 1992.
On box, Tumby, Lincolnshire, 1921.

D. controversa (Desm.) Nke. in Fuck. Symb. Myc. Nachtr. 1 (1871), p. 319. *Sphaeria controversa* Desm. in Ann. Sci. Nat. Ser. II, XVII (1842), p. 102.
Taking Winter's diagnosis of Desmazières' plant it is the common *Diaporthe* on ash in England and *D. obscurans* Sacc. does not seem separable. It is decidedly variable, the black line sometimes penetrating the wood deeply, sometimes not at all. The perithecia are sometimes with base immersed in the wood, sometimes wholly corticolous. The ostiola, however, are always short, thus distinguishing it from *D. scobina* Nke. A *Diaporthe* that I have found on *Ligustrum* seems indistinguishable but is, I suspect, *Diaporthe* (*Euporthe*) *ligustrina* Ell. and Everh. Though the sections *Euporthe* and *Tetrastaga* are convenient, no sharp line divides them, as experience in the field soon proves. Personally I consider *D. controversa* to occur on both *Fraxinus* and *Ligustrum*, even if *D. ligustrina* Ell. and Everh. and *D. Ligustri-vulgaris* Petrak are distinct species.

**D. patria* Spegazz. in Atti Soc. Crittogam. Ital. III. (1881), p. 53.
D. sorbicola (Nke.) Schroet. in Krypt-Fl. Schles. III. 2 (1897), p. 428.
On *Pyrus Aucuparia*, Keswick, Sept. 1922. The spores were 16–20 × 4–5 μ, larger than those described by Schroeter and by Traverso.

**Coronophora angustata* Fuck. in Fung. rhen. No. 1854.

On beech, Lytchett Matravers, Dorset, April, 1922. This fungus is close to *C. gregaria* Fuck. but has much smaller spores. The peculiarities of the fructification of this species are described by Petrak in Ann. Myc. XIX (1921), p. 182. He thinks the manner in which the asci are evolved affords support to the correctness of von Höhnel in creating a family Coronophoreae.

BARK CANKER DISEASE OF APPLE TREES CAUSED BY MYXOSPORIUM CORTICOLUM EDGERT.

With Plates IX–XI and 3 Diagrams in text.

By Grace G. Gilchrist, B.Sc.

Introduction.

At Long Ashton in 1920, a disease was noticed in a plantation of bush apple trees doing very severe damage to the branches. In some cases, only one branch was affected, in others four or five branches were attacked and in others the disease had reached the crown of the main trunk and the trees were doomed. A character of the disease was the formation of large longitudinal scars on the sides of the branches and this symptom, together with the occurrence of numerous pustules of spores of the fungus *Myxosporium corticolum* Edgert., led to the identification of the disease as bark canker. Hitherto this disease had not been reported in this country although it has been known in the United States for some years.

Historical Notes.

In 1908 Edgerton(1) briefly described the bark canker as being produced by a new species of *Myxosporium*, which he named *Myxosporium corticolum*. He found the fungus to be perennial, living from year to year in the bark and forming a new ring of growth each year. The description which he gives of the appearance of the disease agrees closely with the symptoms observed at Long Ashton and which are described in detail later. The spore pustules were small, about 1–2 mm. in diameter, slightly raised at the place where the bark was ruptured. The spores were observed to ooze out of the pustules in white tendrils, but they readily separated in water. He described

them as long, cylindrical, hyaline, perfectly characteristic of the genus *Myxosporium.*

In nutrient solution, the spores germinated readily, a germ tube being put out during the first day, generally near one end of the spore. During the second day the spores usually became 1–3-septate and of a decidedly brownish tinge and later other germ tubes developed. After germination the mycelium grew very slowly, only producing a colony about 3 mm. in diameter in two weeks. Edgerton did not succeed in obtaining spores in artificial culture.

Lewis(2) in 1912 isolated the species from diseased apple branches. He transferred the fungus from plates to bean pods where it fruited and produced spores identical in shape and size with those from pustules on apple branches. Inoculation experiments which were carried out were not satisfactory and Lewis came to the conclusion that *Myxosporium* is not the sole cause of the killing back but that it attacks weakened branches, hastening their death and giving the appearance that they had been killed by a more active parasite than this fungus seems to be.

Stewart, Rolfs and Hall(3) in 1900 referred to this fungus as *Macrophoma Malorum* (Berk.) Berl. and Vogl. The opinion had previously been advanced that *Macrophoma Malorum* was an immature stage of *Sphaeropsis Malorum* Peck, but Stewart and his associates believe that the two forms are distinct. Subsequently (1910) Stewart accepted Edgerton's(1) name.

Hesler and Whetzel(4) in 1917 included a brief description of the disease in their Manual of Fruit Diseases. They state that the fungus is confined to the cortex, and that the originally infected areas are small and more or less circular, but larger cankers of various shapes finally appear as the result of the coalescence of two or more cankers, but that the fungus is responsible for such slight damage that it is very doubtful whether any sort of remedial measures are ever necessary or profitable.

General appearance of the disease.

The most characteristic feature of the bark canker disease is the extremely long narrow scars which it produces. These may run for a length of two or three feet down one side of a stem and not reach a breadth of more than 1½ inches. The disease may start at the top of one of the main branches and grow downwards, or it may develop from the soil level infecting the trunk and causing the rapid death of the tree. The dead area of the scar is somewhat sunken below the surrounding tissue owing to lack of new growth. The edges of the scar are usually

well defined by a rather deep crack and sometimes the formation of a callus round the healthy regions is noticeable during the summer. Pl. IX, fig. 1, represents a scar as it occurs in the middle of a branch although usually a scar of this sort is associated with a dead truss. Pl. IX, figs. 2, 3 and 4, are of a branch which became infected at the top, the disease progressing downwards. One occasionally finds scars which have become completely healed over by the growth of wound wood formed by a cambium at the edge of the scar (Pl. IX, fig. 5). Normally, however, this is prevented by the growth of the fungus.

The dead tissue is usually found covered with innumerable small fructifications scattered over its surface. Under normal conditions only the openings of the fructifications can be seen, but after a damp foggy night the spores accumulate at the openings and can be recognised as small white points (Pl. IX, fig. 6). After a shower of rain the spores are washed away and are no longer visible to the naked eye.

A rather unusual feature of this disease is the seasonal activity of the fungus. At only one period of the year do the scars increase, usually towards the end of summer, but this varies according to the season. In 1920, at Long Ashton, they started growth in October. In 1921, a much earlier ripening year than 1920, they started in August; whilst in 1922—a late season—the very first signs of the extension of the scars were visible on July 19th, but it was not until September that the fungus was really active. After a comparatively short period during which time the scars extend rapidly, the fungus becomes quiescent and remains so until the following year when it once more bursts into new growth. The interesting point is that although the fungus is always present, and presumably ready to grow, yet it is only at one period during the annual cycle that it can do so. The cause of this is obscure, but one cannot help thinking that the physiological condition of the tree, or perhaps of the fungus, or possibly of both, alters during the time when growth of the fungus is just taking place. The first sign of any activity on the part of the parasite is the appearance of faint cracks in the bark some little distance below a scar (Pl. IX, fig. 4). These cracks, which at first may be entirely dissociated from any previous crack, become more distinct in a few days and finally link up to form a well-defined line of demarcation at the edge of the bark canker, between the healthy and what subsequently becomes diseased tissue. The tissue within the crack browns and dies off, producing, after some little delay, the usual fructifications. The rapidity with which the fungus advances, once it has started into activity, is rather striking. With the canker produced by *Nectria galligena* and *Monilia cinerea*, the host

plant limits the progress of the fungus by the formation of successive cork layers, not very far distant from each other. In the present case, however, the cork layer is formed at very great distances from the old ones, sometimes 5 or 6 inches, or even more. A scar may progress longitudinally as much as 18 inches at a single step, although in a transverse direction it rarely exceeds $\frac{1}{2}$ inch.

The opinion of American workers appears to be that the fungus is confined to the cortex and that the damage resulting from it is negligible. That may be so under American conditions, but in the case of the two outbreaks which have been recorded in England severe damage was being caused. It may be that the fungus becomes virulent when the trees are in a starved condition, but once it gets a firm hold on a plantation it may cause the loss of many trees. Not only the cortex is affected but also a large part of the woody tissues.

Description of the fungus.

1. *Appearance of fungus in tissues.*

The hyphae of *Myxosporium corticolum* are hyaline and vary greatly in thickness from 1 μ to 3·4 μ. The mycelium is mostly confined to the cortex and at first does not penetrate far into the wood, but later penetrates as deeply as the wood of the second year. It grows freely in the dead tissue and is very abundant in the cortex and outer phloem. It is found chiefly in the air spaces of the cortex, but also in the cells themselves. In the wood the hyphae are confined almost entirely to the vessels and pass from one vessel to another through the pits (Pl. XI, figs. 13, 14 and 15).

2. *Distribution of mycelium in a mature canker.*

In its first stages the bark canker disease is essentially a bark disease but eventually the remaining part of the stem also becomes infected. Fig. 10 is a photograph of the diseased branch shown in Pl. IX, figs. 2, 3 and 4, cut transversely at distances 4 cms. apart arranged in rows from below upwards. In the lowest section (row 1) the only sign of disease was the presence of two cracks in the cortex, which were evidently the cracks where the scar was extending and which are very clearly marked in fig. 4. In the second section, the cracks were more prominent but the tissue between them was not discoloured. The fourth section showed dead tissue between the cracks, although such tissue was almost confined to the cortex, and of course represented the dead tissue of the old scar which had been killed long ago. The other sections revealed the presence of the scar

in the cortex. The wood finally became more and more diseased until the whole tissue was killed. Examining these sections microscopically fungal hyphae were not found in those of the first row although the fourth and fifth showed the wound reactions of the cortex and dark portions in the wood due to wound gum. The remainder of the sections (rows 2, 3, and 4) represent the older diseased parts. All these were heavily infected by fungal hyphae and wound gum was formed in large quantities in the wood vessels and in the thick walled wood parenchyma but not in the medullary rays, the phloem, or the cortex. Thus it is evident that wound reactions of the cortex and the formation of wound gum takes place much in advance of penetration by mycelium.

3. *Method of advance of the mycelium.*

The microscopic details of the way in which the mycelium advances in the tissues are interesting. As described above the sudden appearance of cracks in the bark denotes the extension of the scar and if a transverse section is taken at such a level, nothing abnormal can be seen in the cortex except the deep cracks, usually two, which mark the area to be infected. A slight tendency of the tissues limited by these cracks to redden more rapidly than the normal cortex is sometimes observed. The cracks are usually almost radial and extend somewhat deeply into the cortex, almost if not quite, reaching the wood. Further toward the old infection, long zones of browned tissue are sometimes formed in the phloem region. These zones may extend tangentially (i.e. parallel to the circumference and concentric) for considerable lengths, isolated portions of brown tissue joining up laterally but never radially. There may be one, two or even three of them running parallel to each other but quite disconnected. They consist of dead tissue and may reach a thickness of 100–140 μ separated by rings of normal phloem about 150 μ in width. The cell walls of the normal phloem measure about 1·5 μ thick, but in the browned zones they are swollen to 3 to 4·5 μ in thickness. Occasionally the cell contents in the affected area are turned brown and coagulated, and the portion of a medullary ray which may sometimes be found passing through the dead tissue is usually similarly affected. In the phloem, between the concentric browned zones, large numbers of crystals occur which physical and chemical tests show to be calcium oxalate (Pl. IX, figs. 8 *a*, *b* and *c*).

The occurrence of these zones is not invariably associated with bark canker, but they have been found in a number of cases so that they appear to be caused by *Myxosporium corticolum*.

No hyphae are found in the browned zones at first but as one follows them back to the older infected parts the extent of the browned zones increases, the cortex dies, wound gum appears in the wood, and finally mycelium gradually becomes visible as has been described above.

4. *Description of conidia and their measurement.*

The majority of the conidia are oval or slightly allantoid in shape, although occasionally they are found to be quite curved, with the result that at one time this fungus was thought to be *Macrophoma curvispora* Peck. The end of the conidium nearest the conidiophore is somewhat bluntly pointed, while the other end is conspicuously rounded. The cell wall is comparatively thick. These conidia are unicellular, hyaline, and contain large refractive globules varying from 1 to 3·5 μ in diameter. The latter are stained brown with osmic acid, and distinctly pink with Millon's reagent and are therefore probably proteid in character. The conidia vary in length from 25 to 45 μ and in width from 9 to 18 μ.

5. *Description of development of the fructification.*

When the fungus is about to produce fructifications, the mycelium at various points just below the epidermis forms small stromatic masses. The epidermal layers are thus raised in the shape of a dome, the covering of which still remains unbroken. The hyphae in the centre of the stroma now begin to elongate perpendicularly to the epidermis and develop into a definite column of tissue, which forces the epidermis out 300–350 μ. The hyphae round the base of the central column do not increase their rate of growth but form a kind of basal disc (Pl. XI, figs. 17 *a*, *b*, *c*). The spores are produced in large numbers from the hyphae on this disc. A hypha becomes constricted immediately below its apex, forming a small oval-shaped portion. Protein material passes from the hypha into this portion which increases in size until it becomes, on an average, 36 μ by 12 μ. Eventually this portion, which is a conidium, is cut off at the point of constriction and the hypha is ready to form more conidia in a similar manner (Pl. XI, fig. 17 *f*). The epidermis remains unbroken until the conidia are ripe. The sterile hyphae of the central column then grow until the layers of bark break. At first only a narrow opening is formed, but as the whole of the fructification grows, the slit widens and the bark is pushed outwards. The conidia are shed into the space between the stroma and the bark. Under suitable conditions of warmth and moisture these are pushed out of the opening in such numbers

as to be visible to the naked eye as white points (Pl. XI, figs. 17 *d*, *e*). No other form of fructification has been discovered.

Cultural Studies.

1. *General growth on different media.*

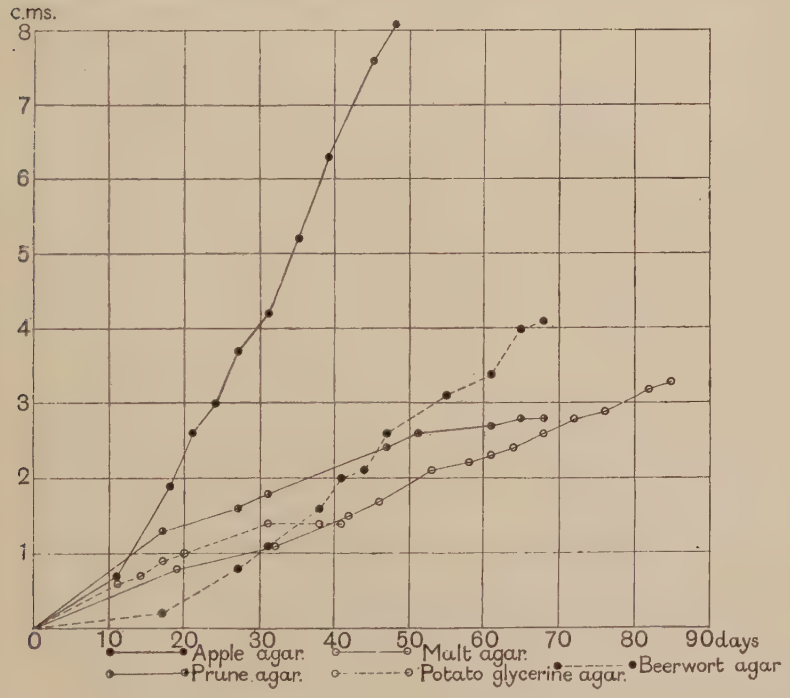
Pure cultural studies of *Myxosporium corticolum* have been made on various media. The characteristic growth of the mycelium, its effect on the medium and any other points of interest are set forth in the following table:

Medium	Effect on colour of medium	Colour of mycelium	Formation of mycelium
Apple twig	— —	White	Hyphae very well developed both on cut surface and where they have burst through the bark. Numerous large drops of amber-coloured to dark-brown liquid. Conidia
Pear twig	— —	Brown and white	Fibrous and not so well developed as on apple twig. Small quantity of amber-coloured liquid
Cherry gelatine	Changed from yellow to dark brown	White on slope culture. White and brown on roll culture	Good growth of flocculent hyphae. No amber-coloured liquid
Cherry agar	Changed from yellow to red	White on slope culture. White, yellow and green on roll culture	Flocculent hyphae, not so well grown as on cherry gelatine. No amber-coloured liquid. Slight formation of concentric rings when grown on a roll culture
Rice	Changed from white to purple-brown	White	Flocculent hyphae, surrounding each grain of rice
Potato stem	— —	White	Inconspicuous growth
Apple fruit	— —	White and grey	Fibrous and flocculent. A few drops of brown liquid
Carrot	Changed from orange to red-brown	White and whitish pink	Good growth. Drops of brown liquid
Maize	From yellow to brown	White	Flocculent hyphae
Cellulose agar	— —	White	Poor growth, thin film of very fine hyphae on surface of medium
Malt agar	From yellowish grey to brown	White	Moderate growth. Large number of small drops of brown liquid formed. Cracks appear in the medium which increase in size and number with age. Conidia are formed in small cream pustules looking like drops of emulsion. Later dark green sclerotia are formed containing conidia
Prune agar	— —	White	Moderate growth. No drops of liquid formed
Apple agar	Crimson in centre of colony, surrounded by band of dark green, edge yellow	White	Flocculent growth. No drops of liquid

Medium	Effect on colour of medium		Colour of mycelium	Formation of mycelium
Beef peptone agar	—	—	White	Centre of colony fibrous, edge smooth and forming a thin film on the surface
Potato glycerine agar	—	—	Old portions brown, young portions white	Practically all the growth is under the surface of the medium, in the form of a solid mass. No drops of liquid
Apple juice	—	—	Orange	Good growth, solidifying the liquid
Beerwort agar	Slightly darkened		White	Very large drops of light brown liquid
Prune juice	—	—	Light brown	Moderate growth
Uschinsky's solution	—	—	White	Poor growth

In the above table it will be seen that grown on certain media the hyphae secrete yellowish and brown viscid drops. In view of the abundance of crystals of calcium oxalate in cultures of the fungus on agar media, this liquid was tested and found to contain oxalic acid. The variations of growth on different media are very great; apple twigs, apple agar, and apple juice are very good media but the fungus prefers gelatine to agar. On no cultures were chlamydospores found and the colonies showed a marked absence of rings. The rates of growth are shown in the following graph:

Rate of growth of Myxosporium corticolum *on various media.*



2. *Temperature relations.*

In order to obtain some information regarding the thermal relations of this fungus, a number of slope cultures were made on malt extract agar and incubated at the temperatures given in the following table. The size of the resulting colonies after six weeks' growth are recorded. It appears that the optimum temperature for growth is about 15° C., the maximum temperature between 25° and 30° C. and the minimum temperature between 0° and 1° C.

Temperature	Measurement of colonies after 6 weeks' growth, cm.
1. Cold storage (0°–1° C.)	1·3 × 1
2 Incubator (15° C.)	5·2 × 2
3. Cupboard in laboratory (15° C. in daytime, less at night)	4·2 × 2
4. 25° C. incubator	3·3 × 1·8
5. 30° C. incubator	nil
6. 35° C. incubator	nil

3. *Production of conidia in pure culture.*

Conidia have been produced in pure culture on sterile apple twigs and on malt agar slopes. Those produced on sterile apple twigs are formed as in nature. In pure cultures of malt agar slopes the process is somewhat different. After four months' growth, dark green irregular roundish bodies were noticed (Pl. X, fig. 9). On examination these proved to be little masses of stromatic tissue where the hyphae were twisted together to form a kind of sclerotium. Sections through these bodies showed that they contained large numbers of conidia. Pethybridge (5) mentions a similar occurrence in *Colletotrichum Tabificum* (Hallier) Pethybr., a fungus closely related to *Myxosporium*. In *Colletotrichum* this is the only form of fructification and the sclerotia-like bodies are found on dead or dying potato stalks, especially on the parts below ground. So far no corresponding bodies have been found in nature in connection with *Myxosporium corticolum*.

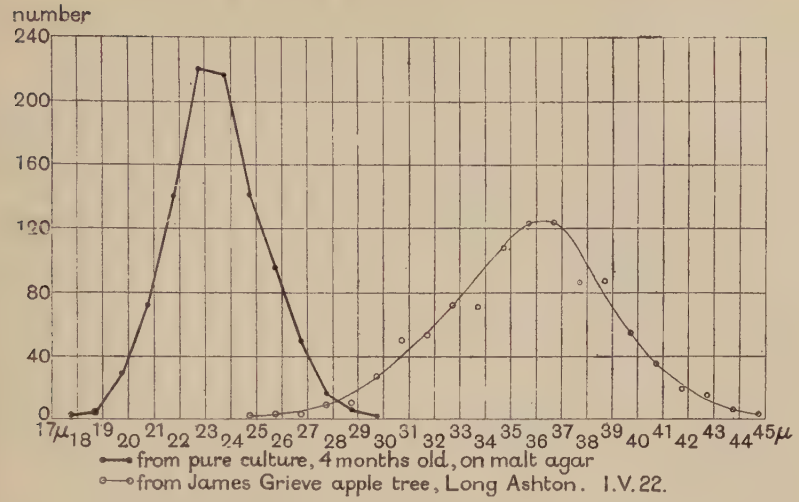
4. *Difference of conidial measurements from those occurring in nature.*

A careful study of spore measurement has been made both of spores from the apple branch and from those produced in pure culture.

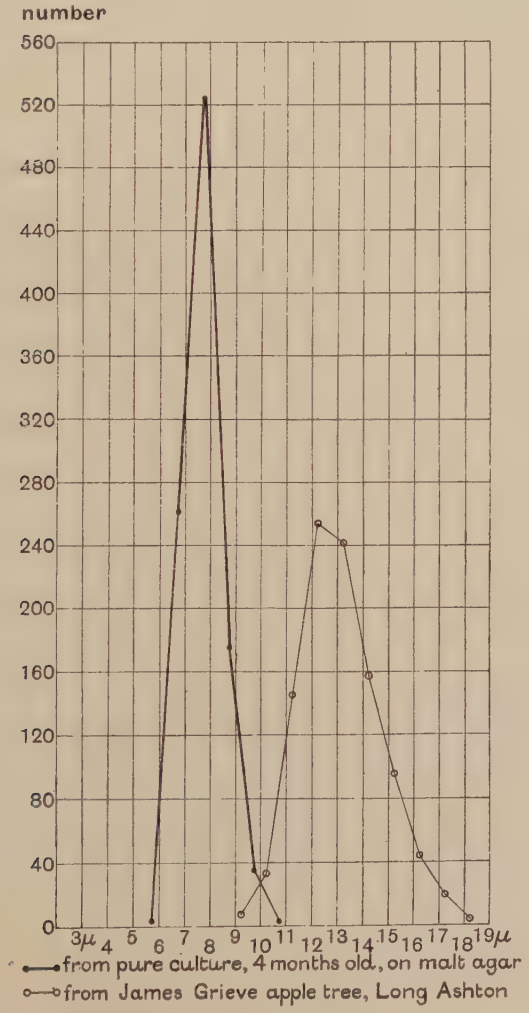
Fresh material was collected in May 1922 from the variety James Grieve and 1000 spores measured. They varied in length from 25–45 μ, the largest number being 36 μ in length. The width varied from 9–18 μ, the majority being 12 μ in width.

The spores developed in pure culture were distinctly smaller. This observation disagrees with that made by Lewis (2), who,

Length of Spores of Myxosporium corticolum.



Width of Spores of Myxosporium corticolum.



in a pure culture grown on bean pods, obtained spores of the same size as those produced on apple branches. Measurements were made of 1000 conidia from a pure culture grown on malt agar. Here the length varied from 17·5 μ to 29·5 μ, the majority being 25 μ in length, and the width varied from 6 to 10·5 μ, the majority being 7·5 μ in width.

The graphs on p. 239 give the frequency curves for conidia produced naturally and artificially.

5. *Germination of conidia.*

The conidia germinate very readily even in distilled water, and the germination of single spores was followed in a number of cases. In Pl. X, fig. 12 (*a*) represents a conidium from a hanging drop culture in a dilute solution of malt extract. It remained on a bench in the laboratory at about a temperature of 15° C. during the daytime and slightly less at night. In 16 hours a germ tube had been put out from one side, nearer the round end than the pointed end of the spore. When the culture was 48 hours old, this germ tube had grown considerably, becoming septate and branched, while a cross wall had formed in the spore dividing it into two cells approximately equal in size. When four days old, the spore was found to have put out a second germ tube which arose from the other end of the spore, that is, the pointed end. Each of these germ tubes grew and branched giving rise to the colony shown in Pl. X, fig. 12 (*h*). Observations of other germinating spores showed that the procedure described above approximates the normal. The first germ tube may arise from either end of the spore and is usually initiated before the spore divides into two cells. The second germ tube is developed from the second cell and therefore from the opposite end of the spore within about three days.

Inoculations.

The association of *Myxosporium corticolum* Edgert. with the bark canker disease has been recorded by four sets of observers previously and it seems extremely probable that it is responsible for the disease. Lewis(2) only, however, has obtained a successful infection from an artificial inoculation. "On one branch inoculated with *Myxosporium* the typical killing back which is characteristic of branches on which this fungus so frequently occurs was found. Other branches failed to show any injury whatever due to the inoculations." The exact number of inoculations was not recorded but seventeen are definitely mentioned.

The total number of inoculations made at Long Ashton amount to 45, but so far no definite signs of successful infection

have resulted. The methods of inoculation have been varied so as to obtain the conditions thought to be most likely for success. The method which gave most promise was the injection of a spore suspension by means of a hypodermic syringe. These inoculations, however, at six months only show very small scars about 5 mm. in diameter.

The results from these experiments support the views of the American authors that the fungus is only a weak parasite and only under exceptional conditions does it become dangerous. When these conditions are reached, however, much permanent damage is done to the trees and they may be killed outright.

Method of infection in nature.

Trees which are being attacked by *Myxosporium corticolum* are usually in a weak state and dead spurs are not infrequent (Pl. IX, figs. 2, 5 *a*). On such dead spurs the fructifications of the fungus have frequently been observed and possibly entrance to the tree is gained by this means. Occasionally a fungus with a much smaller spore ($9\mu \times 3\mu$) and resembling *Myxosporium Mali* Bres. has been found on apple branches, but it is quite distinct from *Myxosporium corticolum*. This is interesting in view of the observations recorded by Marchal (6) who obtains considerable variations in the character of *Fusicoccum Malorum* Oud. in culture, especially as regards the dimensions of the perithecial necks and the grouping of the perithecia. So much so that it seems possible that several forms, *Aposphaeria Pomi* Sacc. and Schulze, and *Myxosporium Mali* Bres., are merely variations of *Fusicoccum Malorum* Oud. *Diaporthe perniciosa* March. hibernated on the branches of pear and apple, producing a canker in the outer layers of the bark. The bark infections give rise to numerous pycnidial stromata in the autumn which remain hidden in the external layers, thus simulating certain species of *Myxosporium*.

Another method by which infection takes place is through grafting-wounds. In a nursery at Sandford in Somerset a number of young standard trees were found to be infected with *Myxosporium corticolum*, the fungus evidently had entered through the exposed surface of the stock, the saddle type of grafting having been used. Pl. IX, fig. 7, shows a photograph of a specimen obtained from this source.

Occasionally also, one finds trees which had evidently become infected from the base. Usually other fungi are present in such abundance that it is impossible to identify the original parasite. Recently, however, a ten year old bush tree of the Lord Suffield variety died off very suddenly during July and close examination of the main trunk showed the typical fructifications of

Myxosporium corticolum in enormous numbers. The method by which the fungus enters the tree in this case can only be conjectured, but it evidently came from the region of the ground.

Summary.

1. *Myxosporium corticolum* Edgert. is the cause of bark canker disease.

2. A characteristic of the disease is the formation of large longitudinal scars on the sides of branches, on the dead tissue of which numerous acervuli are found.

3. The scars increase rapidly at one period of the year only, usually towards the end of the summer.

4. The fungus is most abundant in the cortex, but also occurs in the phloem, and the wood.

5. In the wood infected by the hyphae wound gum is formed in large quantities in the wood vessels and in the thick walled wood parenchyma, but not in the medullary rays, the phloem, or the cortex.

6. Wound gum is formed in advance of the hyphae.

7. Conidia are produced in acervuli; they are oval or slightly allantoid in shape and measure 25–45 μ × 9–18 μ. They germinate easily.

8. In pure culture hyphae grow very slowly, preferring gelatine to agar. On certain media the hyphae secrete drops of brown liquid which contain oxalic acid. Crystals of calcium oxalate are invariably found in the media on which *Myxosporium corticolum* has been growing.

9. In pure culture conidia have only been formed on apple twigs and 2 % malt agar. In the latter case they are formed inside a dark green body, in appearance like a sclerotium.

10. As a result of inoculations, *Myxosporium corticolum* seems to be a weak parasite except under certain conditions. When these conditions are reached, however, much permanent damage is done to the trees and they may be killed outright.

11. The fungus in some cases enters through a dead spur; in other cases infection comes from the region of the ground. Infection may also take place through grafting wounds.

I take this opportunity of thanking Mr S. P. Wiltshire who originally suggested this investigation, and also provided material, and took an active interest throughout.

I also wish to thank Professor O. V. Darbishire and Professor B. T. P. Barker for their advice and interest in this work.

Cryptogamic Research Laboratory,
The University,
Bristol.

November, 1922.

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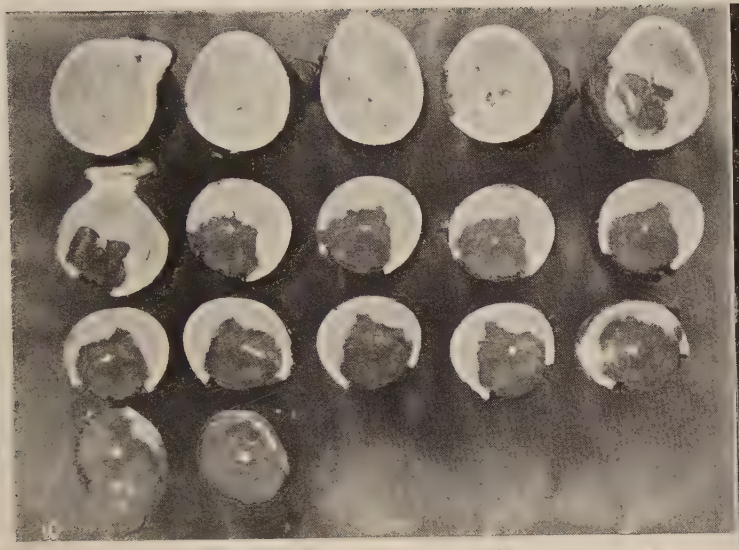

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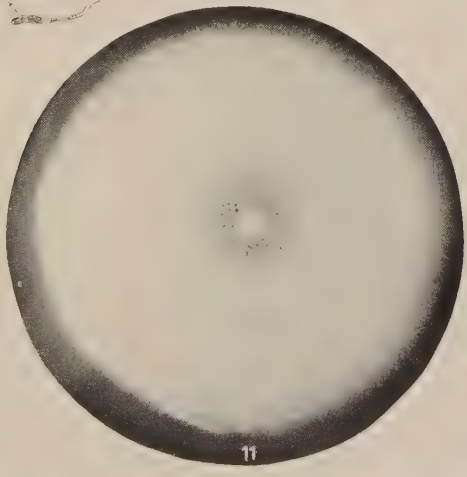
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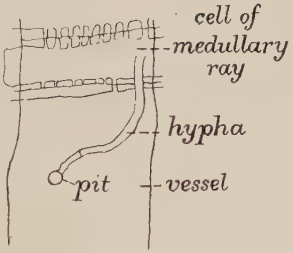

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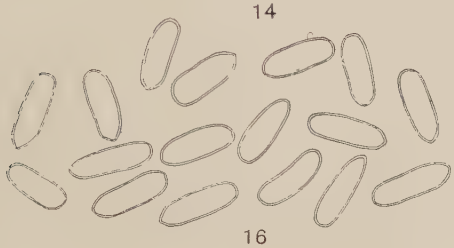
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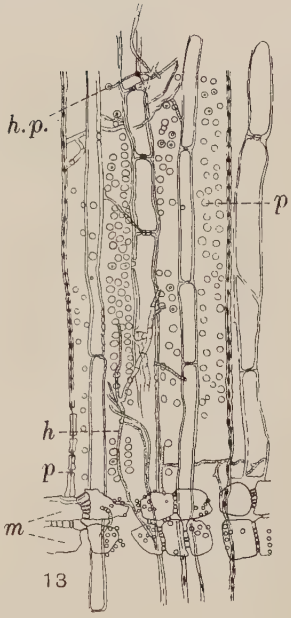

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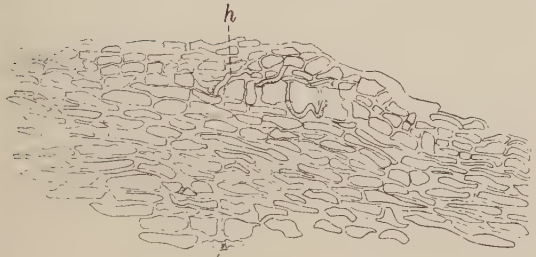

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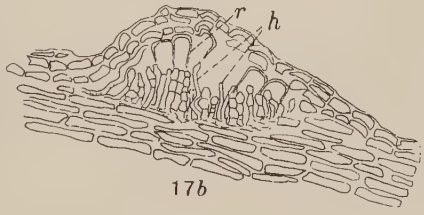

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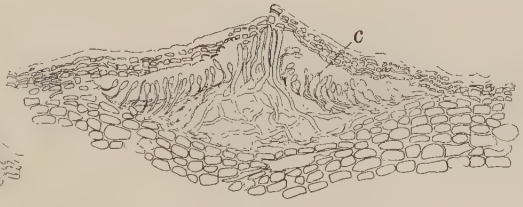

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DESCRIPTION OF PLATES.

Plate IX.

Fig. 1. Typical scar caused by *Myxosporium corticolum* Edgert. on apple tree, 5 November, 1920.
Fig. 2. Whole branch of James Grieve apple tree killed by *M. corticolum*, 24 August, 1921.
Fig. 3. Near view of same branch.
Fig. 4. Near view of same branch showing new scar forming.
Fig. 5. Scar caused by *M. corticolum* completely healed over by the growth of wound wood.
Fig. 5 *a*. Scar of *M. corticolum* with dead spurs.
Fig. 6. Pustules of *M. corticolum* on James Grieve, 29 October, 1920.
Fig. 7. *M. corticolum* on young standard apple tree, Sandford, Somerset, December, 1921.
Fig. 8. (*a*) Tr. section of apple branch showing line of dead tissue in phloem (*d*).
(*b*) Portion of above. ×10. *x* = xylem; *p* = phloem; *m* = medullary ray; *d* = dead tissue; *f* = fibres.
(*c*) Same. ×45. *c* = crystals of calcium oxalate.

Plate X.

Fig. 9. Streak culture of *M. corticolum* showing formation of spore masses on malt extract agar, January, 1922.
Fig. 10. Tr. sections (4 cm. thick) of branch shown in Figs. 2, 3, 4, 25 August, 1921.
Fig. 11. Plate culture of *M. corticolum* on prune extract agar, incubated at 20° C., four weeks old, 11 March, 1922.
Fig. 12. Germination of single spore of *M. corticolum*.

(*a*)	November 15, 11.30 a.m.	×100.	(*e*)	November 18, 9.45 a.m.	×100.
(*b*)	,, 16, 3.45 p.m.	×100.	(*f*)	,, 19, 11.15 a.m.	×100.
(*c*)	,, 17, 11.15 a.m.	×100.	(*g*)	,, 20, 10 a.m.	×100.
(*d*)	,, 17, 5.15 p.m.	×100.	(*h*)	,, 22, 11.30 a.m.	×10.

Plate XI.

Fig. 13. Mycelium of *M. corticolum* in the wood of apple. *h.p.* = hypha entering pit; *h* = hypha; *p* = pit; *m* = medullary ray. ×180.
Fig. 14. Long. section of wood vessel showing hypha passing into pit. ×420.
Fig. 15. Long. section of wood vessel. ×420.
Fig. 16. Spores of *M. corticolum* from James Grieve apple tree. ×260.
Fig. 17. (*a*) Tr. section of apple bark. 1st stage of acervulus. *h* = hypha. ×130.
(*b*) ,, ,, 2nd stage. *r* = stretched radial walls of bark. ×130.
(*c*) ,, ,, 3rd stage. ×100.
(*d*) ,, ,, 4th stage. *c* = conidium. ×90.
(*e*) ,, ,, 5th stage. ×100.
(*f*) Development of a conidium. ×390.

A NEW SPECIES OF SIGMOIDEOMYCES THAXTER.

With Plate XII.

By R. C. McLean.

In November 1921 a fungus was discovered growing on the surface of soil in a pot in the greenhouse attached to the Botanical Department, at University College, Cardiff, which proved to be a new species of *Sigmoideomyces* Thaxt., a genus of Mucedinaceae.

This genus has a curious history. The type species is *S. dispiroides* Thaxt., described from Burbank, E. Tennessee; habitat rotten wood. A second species was found by Mrs Bayliss Elliott at Birmingham and described by her under the name of *S. clathroides*. The present form makes a third species. The genus has therefore only been seen thrice, at widely separated stations and on each occasion in a different specific form.

The species under consideration was found on the soil in a pot in which seeds of *Impatiens sultani* had been sown about ten days previously. The soil was of the same blackish or sooty tinge, common in city gardens, as that on which the Birmingham specimens were found, giving a slightly acid reaction at about *p*H 6·0. It had not been long in the pot, but had been in use for potting purposes in the greenhouse for some time. The average temperature of the greenhouse during November is 65°–70° F. and it is neither very light nor very well ventilated.

As Mrs Bayliss Elliott connects the occurrence of her species with the presence of dead earthworms in the soil, I should say here that there did not appear to be any dead worms in the original pot of soil, though they may have disappeared by decay before I turned it out some time later; neither have attempts to recover it by enclosing samples of the soil, containing dead worms, in stoppered glass jars, been successful, though they have stood the full six months Mrs Bayliss Elliott found necessary for its development. This does not however disprove the interesting correlation which certainly appeared in her cultures. Attempts to obtain artificial cultures were unavailing, though several times repeated, owing to the abundance of bacteria both on and around the conidial fructifications. The wild growth disappeared after about six weeks and has not been seen since.

The naked-eye appearance of the fungus is that of a number of buff-coloured, fluffy balls, about 1 mm. in diameter and 2–3 mm. apart, dispersed in patches on the surface of the soil, the connecting, sterile mycelium being so fine as to be scarcely visible. These balls are the conidial fructifications, each com-

posed of a radiating mass of tapering, branched and apparently dichotomising hyphae, from which arise laterally the globose conidiophores on slender pedicels. The conidiophores are borne only on the stouter branches, towards the centre of the mass, so that they are protected by the sterile, apical portions of the hyphae. They arise in pairs, one on each side of the large cells which form the angles of the dichotomies.

The branching of the upper portions of the hyphae is strictly monopodial and in spite of appearances I am persuaded that it is so throughout and that the apparent dichotomy of the basal portions is due to secondary divergence of branches which are not in reality of equivalent rank. Reference to Pl. XII, fig. 5 will make this point clearer. Each conidiophore bears 25–30 short, conical sterigmata on each of which is one spherical, minutely echinulate conidium. The development of the conidium follows that of the conidiophore in point of time, being budded off when the latter has practically reached its full size. Both conidia and conidiophores are very caducous and the latter also readily collapsible, except perhaps when fully mature. The angle-cells, likewise, on which they are borne seem easily distorted by the leverage of the branches.

One curious feature, in which this species is peculiar, is the development of little prominences on the cells towards the apex of the filaments, easily seen with a low power and suggesting sterigmata, though no propagative bodies have ever been seen attached to them. High magnification on the other hand, reveals that each hypha bears a dense epiphytic flora of filamentous bacteria (*Leptothrix*?) which look exactly like flagellar appendages, particularly as one or more is regularly attached to each of the aforementioned prominences.

The vegetative mycelium, from which these perithecial-like balls of hyphae arise, is scanty and consists of long, unseptate filaments with an average diameter of 2–3 μ and very sparingly branched.

The claim of this new form to specific distinction rests on the following points:—(*a*) The rectilinear fertile hyphae, lacking that sigmoid curvature whence the genus takes its name. This is an important departure from the type, although in a character probably subject to environmental modification, but the *ensemble* of habit and structure undoubtedly points to its inclusion in the genus even though it should thus render the generic name no longer apt. That is not a matter on which too much stress need be laid for the validity of this or indeed of most genera does not rest on a single feature but properly on the syndrome of characters in the generic definition. (*b*) The rigidly divaricate and pseudo-dichotomous branching of the fertile hyphae. (*c*) The prominences on the apical portions of these hyphae.

(*d*) The smaller conidia with exosporic emergences, less prominent, however, than in the type species.

The present form, which I call *Sigmoideomyces divaricatus*, is notably more closely allied to Thaxter's American species than to the Birmingham one.

Mrs Bayliss Elliott raised the interesting question whether *Sigmoideomyces* was congeneric with *Gymnoascus*. The resemblance of these masses of fertile hyphae to the perithecia of that genus is certainly striking but the conidial and ascigerous forms have not been found in conjunction and the matter is still open. It must be admitted, however, that the Birmingham species, *S. clathroides*, is more like *Gymnoascus* than are either *S. dispiroides* or *S. divaricatus*.

SIGMOIDEOMYCES Thaxter, emend.

Fertile hyphae septate, loosely aggregated and either bent into many sigmoid curves or radiating from a common centre; branching sub-dichotomous, the ultimate branches sterile. Conidiophores vesicular, spherical, borne laterally on the hyphae by a stalk. Sterigmata short, spine-like, scattered. Conidia one-celled, spherical, echinulate or almost hyaline.

S. divaricatus n.sp. Fertile hyphae forming buff-coloured tufts about 1 mm. in diameter and 2–3 mm. apart; the hyphae rigid, radiating from a common centre, tapering, the ultimate branches freely divaricating and bearing laterally small, conical protruberances. The cells at the angles of dichotomy, in the inner part of the tuft, bear each two short, cylindrical outgrowths, in a plane at right angles to that of the branching, each terminating in a thin-walled, spherical conidiophore, 20 μ (15–25 μ) in diameter, upon which are borne the conidia 6–9 μ, minutely echinulate, hyaline. Sterile hyphae forming a scanty mycelium, each being about 2–3 μ in diameter.

On surface of soil in pot. Greenhouse: Botanical department: University College, Cardiff.

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EXPLANATION OF PLATE XII.

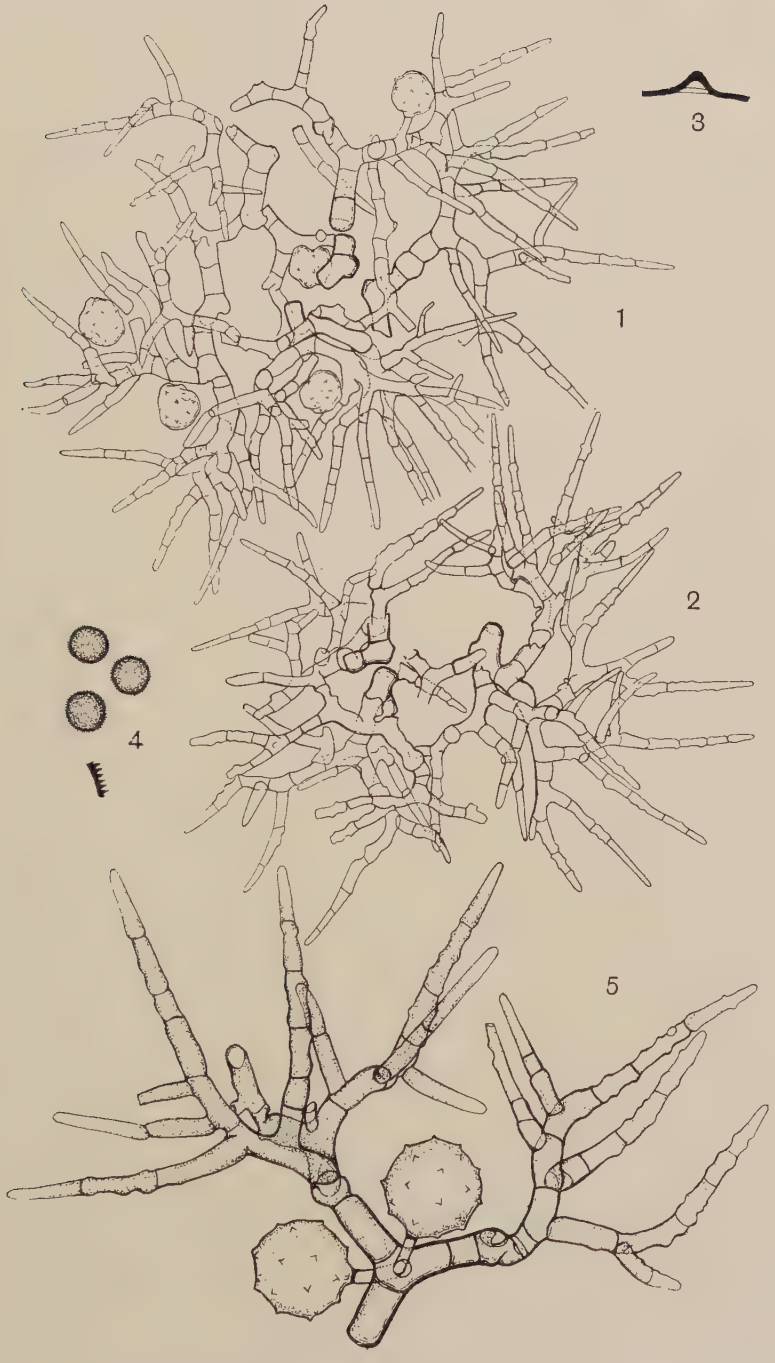
Fig. 1. *Sigmoideomyces divaricatus*. A small "perithecial" tuft of fertile hyphae, teased out, showing the conidiophores, from which the conidia are detached. ×200.

Fig. 2. Portion of an older tuft; the conidiophores having fallen off. ×200.

Fig. 3. A single sterigmaton. ×2000 ca.

Fig. 4. Conidia, and a portion of the conidial wall in section, showing the minute prominences. Conidia ×750.

Fig. 5. Fertile hyphae, illustrating the mode of branching and the attachment of the conidiophores. ×750.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WART DISEASE OF THE POTATO.

PRELIMINARY EXPERIMENTS.

By M. C. Potter, Sc.D., M.A., F.L.S.

For some time it has been recognised that certain plants are associated with acid and others with alkaline soils, and that soil acidity or alkalinity is a determining factor in the distribution of plants. Atkins has recently correlated the range of hydrogen ion concentration with the growth of over one hundred plants. In a similar manner it is found that micro-organisms are also sensitive to culture media. Potts showed in 1905 that the turnip disease known as Finger-and-Toe was absent from slightly alkaline soils; Jamieson and later Atkins have also noted that this disease is more prevalent in acid soils.

A series of experiments have been instituted in the Botanical Department of Armstrong College to determine the limits of hydrogen-ion concentration between which the potato can live and also to determine the *p*H range of *Synchytrium endobioticum*, the causal organism of wart disease.

The experiment consisted in growing a non-immune variety of potato in soils of varying *p*H concentration, and ordinary garden soil taken from an old allotment was employed for the purpose. In the previous year this soil had been infected with wart disease and a crop of badly infected potatoes grown upon it. It was therefore a soil in which wart disease would occur and was in every way suitable for the experiment.

The variations of soil alkalinity were brought about by the applications of different amounts of washing soda crystals and of chalk.

Large ten-inch flower pots filled with the treated soil were sunk in the ground out of doors and a seed potato was planted in each.

Controls. Two controls were taken; one of the original soil and the other of this soil specially mixed with wart diseased potatoes. The potatoes planted in both these pots gave rise to tubers infected with wart disease.

Washing soda. Six pots were used and to the soil in these pots was added respectively 14, 28, 56, 112, 168 and 244 grams of washing soda. The soda was dissolved in water and poured over the surface of the soil. Any water running through was caught in a porcelain pneumatic trough and poured over the surface again, this operation being repeated until the water was all absorbed by the soil. The soil from each pot was then separately turned out, thoroughly mixed, and replaced. The *p*H of the soil in these six pots was found to be approximately 8, 9, 9·5, 10, 10·5 and 11, the soil as taken from the garden being approximately 7·5.

The non-immune variety Up-to-Date was used and a single tuber planted in each pot, about the middle of April. The shoots from the potatoes appeared above ground in the usual time, except in the pots with 168 and 244 grams of soda. In the former of these the shoot from the germinating potato was somewhat later in pushing its way through the soil and in the latter the shoot failed to appear. The tuber when removed from the soil showed that the eyes had commenced to germinate but had failed to develop and had died off; the roots had also failed to penetrate the soil. This tuber was encouraged to germinate and was again planted in the same pot. Later in the summer, when the excessive rain had leached some of the soda from the soil, a very stunted growth was produced, with a few tubers ranging from the size of a pea to that of a bean. The old tuber did not decay in the soil. It may be assumed that the higher limit of soil alkalinity had been attained by the application of such a large quantity of soda.

The following table shows the *p*H concentration at the commencement and at the conclusion of the experiment and also the occurrence of the disease. It will be noted that the wart disease did not appear in the pot with 168 grams of soda.

Pots	*p*H concentration		
Grams of soda	Commencement	Conclusion	
14	8	7	Wart disease
28	9	7·5	,,
56	9·5	8	,,
112	10	8·5	,,
168	11·5	9·2	No wart disease

(168 grams on a ten inch pot would be approximately 2 ozs. per sq. yard.)

The diminution of the *p*H concentration would be due to the leaching action of the almost continuous rains during the summer of 1922.

A parallel experiment, neutralising the soil with chalk, was also carried out. Two pots were employed filled with soil similarly infected with wart disease, the one having $\frac{1}{8}$ chalk and the other $\frac{1}{4}$ chalk mixed with it. In the first the *p*H varied from 10 at the commencement to 9·5 at the conclusion and in the other pot the same variation was from 11 to 10. In neither of these pots was any wart disease to be discovered upon the tubers.

From these experiments it may be inferred that *Synchytrium endobioticum* is sensitive to a high degree of alkalinity and fails to attack the potato when the *p*H concentration of the soil is in the region of *p*H 10·5.

The experiment was not designed to form any idea of the influence of soil alkalinity upon the yield of tubers, but it may be remarked that soil alkalinity, while preventing wart disease, has a tendency to diminish the crop.

A plan has been set on foot to extend this line of enquiry during the coming year, repeating these experiments and extending them to other varieties of potatoes.

The problem of increasing the acidity of the soil has also been attacked and it is hoped to conduct experiments upon the relationship of soil acidity to wart disease.

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RECORDS OF FUNGI IMPERFECTI.

With 4 Text-figures.

By Jessie S. Bayliss Elliott, D.Sc. and Olive P. Stansfield, M.Sc.

During 1920 and 1921, in the course of collecting material for another investigation, we have met with the following fungi, of which *Septocylindrium leucum, S. melleum, Patellina caesia, P. diaphana* are new species; *Lemalis aurea, Hadrotrichum virescens* var. *Poae, Penicillium silvaticum* are new records for the British Isles, and *Oospora ochracea, Tetraploa aristata* and *Sporodesmium myrianum* seem worthy of note.

SEPTOCYLINDRIUM LEUCUM n.sp.*†

The mycelium forms gregarious superficial white brittle tufts on the surface of pine cones. The hyphae are very short so that the entire tuft is a mass of conidia. These are produced basipetally in repeatedly branched chains and are cylindrical in shape with truncate ends; they measure 10–15 × 1·5–2 μ, are from one to three septate and are produced in great quantities. They are rough, being covered with minute granules which soon disappear in water. The conidia germinate easily in rain water in the course of 24 hours.

This fungus agrees in many details with *Septocylindrium album* (Preuss) Sacc., recorded (without size of spores) by Preuss (in Sturm, Deutsch. Fl. III, 29 and 30 (1851), pp. 73, t. 37) as growing on decaying stumps of wood near Hoyerswerda in Germany, but it is evidently not the same fungus for the conidia are described and figured as definitely spindle-shaped,

* *Septocylindrium leucum* n.sp.

Hyphis conidiophoris brevissimis, in fasciculos gregarios, superficiales, albos, fragilissimos digestis. Conidiis copiosis, cylindricis, truncatis, 1–3 septatis, 10–15 × 1·5–2μ catenas repetite ramosas efformantibus.

Hab. in conis *Pini sylvestris* herba semisepultis toto anno, Tanworth-in-Arden.

† Found also on pine cones sent by Dr C. E. Fairman from Lyndonville, N.Y.

thus contrasting with the cylindrical conidia with truncate ends typical of this fungus.

The fungus is to be found growing on cones of *Pinus sylvestris*, half buried in grass at Tanworth-in-Arden, near Birmingham, all the year round.

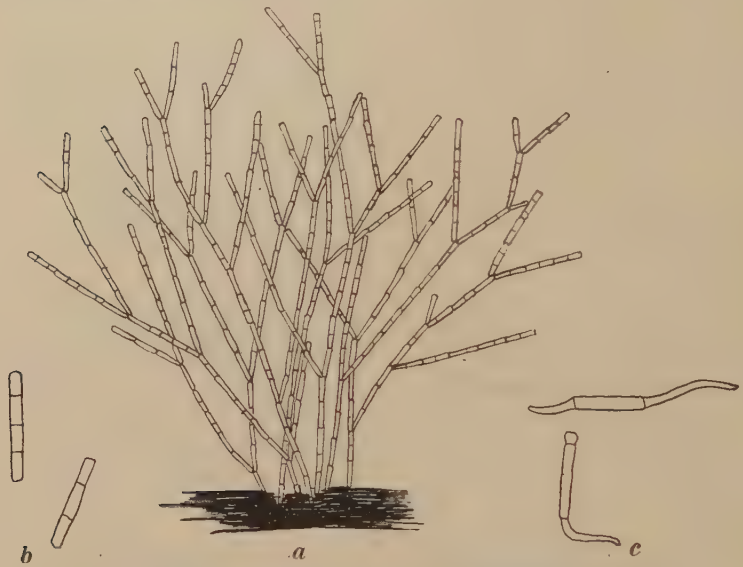

Fig. 1. *Septocylindrium leucum*. (*a*) Sporophore. × 750. (*b*) Conidia. × 1600. (*c*) Conidia germinating. × 1600.

SEPTOCYLINDRIUM MELLEUM n.sp.*

Another fungus similar in nearly all details, except colour, to *S. leucum* was found on the same cones of *Pinus sylvestris* at Tanworth-in-Arden. The appearance of the fungus suggests that it is a buff variety of *Septocylindrium leucum*, but the absence of 3-septate conidia and also of granules makes it advisable to describe it as a separate species.

PATELLINA CAESIA n.sp.†

This fungus was found growing on cones of *Pinus sylvestris*

* *Septocylindrium melleum* n.sp.

S. leuco, praeter colorem, simillimum, at calore melleo, conidiis 1 septatis, species diversa videtur.

Hab. in conis *Pini sylvestris*, Tanworth-in-Arden.

† *Patellina caesia* n.sp.

Excipulum patelliforme, apothecio Discomycetis simile, griseum, pubescens, circa 1 mm. latum.

Hyphis conidiophoris fasciculatis, ramosis, cylindricis, apice in catenas longas sporarum abeuntibus; conidiis hyalinis cylindricis, utrinque oblique truncatis, ca. 10 × 1·5μ.

Hab. in conis *Pini sylvestris*, Tanworth-in-Arden, prope Birmingham.

at Tanworth-in-Arden. Its saucer-shaped form gives it very much the appearance of a Discomycete, but the disc is surmounted by a grey mucilaginous column or dome consisting of innumerable conidia which are washed off by rain and lie around as a grey mucus. The excipulum is composed of pure white hairs arranged parallel to one another, some slightly radiating outwards; when shut up in a very moist atmosphere the hairs stand out almost like those of a Dasyscypha. The

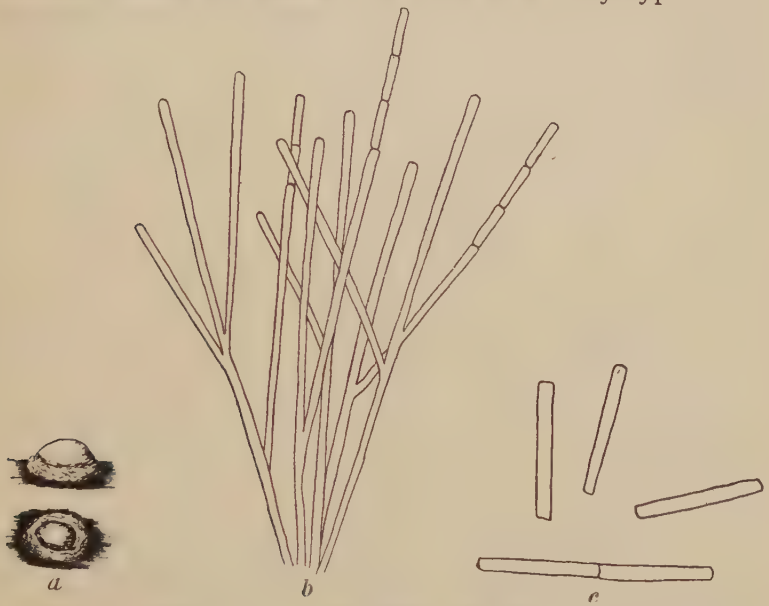

Fig. 2. *Patellina caesia*. (*a*) Pycnidium with dome of spores. × 15. (*b*) Hymenial surface. × 1000. (*c*) Spores. × 2400.

interior of the saucer is lined with a grey hymenial surface, composed of fascicles of branched conidiophores each producing at its apex a long chain of hyaline cylindrical spores, obliquely truncate at both ends, and measuring 10 × 1·5 μ.

The fungus evidently belongs to the Excipulaceae division of the Sphaeropsideae, and it is highly probable that it is the conidial stage of some Discomycete.

PATELLINA DIAPHANA n.sp.*

This fungus was found growing on a dead root of poplar at Tanworth-in-Arden. It has the same form as *P. caesia* and is

* *Patellina diaphana* n.sp.

P. caesiae simillima, sed glabra et tota alba. Conidiis similibus, non longe catenatis, 5–6·5 × 1–1·5μ hyphis longioribus suffultis.

Hab. in radicibus *Populi*, Tanworth-in-Arden. Status conidiophorus Discomycetis.

evidently closely allied to it, but is white in colour. The column of conidia surmounting the disc, as in the above species, is mucilaginous and white. The excipulum having a saucer-shaped form is composed of very narrow parallel hyphae. The interior is lined with branched conidiophores, the branches arising in whorls, near the base. The conidia arise laterally on the conidiophores and do not cling together in chains.

The conidia measuring 5–6·5 × 1–1·5 μ are cylindrical in shape and truncate at both ends. This fungus differs from *P. caesia* in the absence of hairs on the excipulum; in the size and method of growth of the conidia and conidiophores, the conidia being

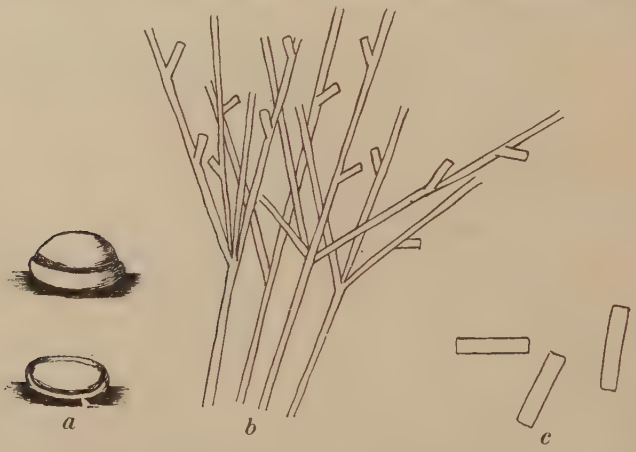

Fig. 3. *Patellina diaphana.* (*a*) Pycnidia. × 20. (*b*) Conidiophores. × 1500. (*c*) Spores. × 2250.

smaller and the conidiophores much longer; also in colour. It is highly probable that this also is the conidial stage of some Discomycete.

Lemalis aurea (Lév.) Sacc. Syll. Fung. III, p. 672 (1884).

Excipulum lemon yellow, cup shaped with a spreading rim, exterior shining, very fragile, 1 × 1 mm. The rim of the cup is marked by hairs which cling together in groups giving it a coarsely dentate appearance. A hymenium of conidiophores lines the pycnidium which is composed of very slender non-septate hyphae ·75 μ wide, each conidiophore consisting of an aseptate hypha with a whorl of four branches at the apex.

The pycnospores are globose, hyaline, 1·5–2 μ diam. and are produced basipetally in chains in enormous quantities. The spores cling together by means of mucus and are exuded from the cup in the form of a straight or tortuous column; a column may be three or four times the volume of the cavity of the

pycnidium. Finally the column of pycnospores topples over and in drops of water the spores quickly disperse.

Very young excipula are extremely shallow in form, some, when measuring 160 μ in diameter and being only 60 μ in height, were producing a great profusion of conidia. The fungus was found on cones of *Pinus sylvestris* at Tanworth-in-Arden.

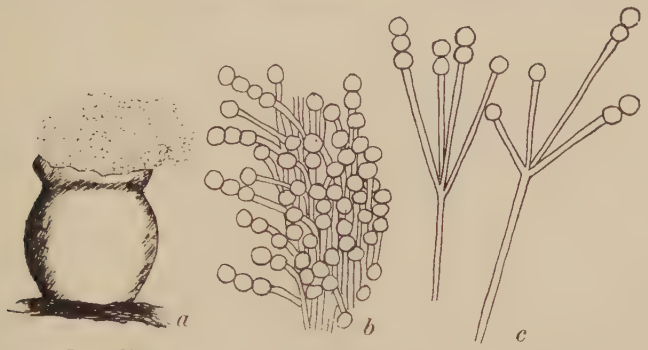

Fig. 4. *Lemalis aurea* Lév. (*a*) Pycnidium with pycnospores. × 15. (*b*) Hymenial surface. × 1000. (*c*) Conidiophores with spores. × 1500.

Hadrotrichum virescens Sacc. and Roum. var. *Poae* Sacc. in Ann. Mycol. II (1904), p. 529.

This fungus, considered by Saccardo to be the conidial stage of *Phyllachora Poae* (Fuck.) Sacc., was found growing on *Poa pratensis* at Tanworth-in-Arden. It forms black cindery stromata on the leaves. These are at first punctiform but soon coalesce to form black patches: the tissue of the leaf round the stroma turns yellow and finally the whole leaf dies.

The dark brown simple clavate conidiophores arise from the stroma in fascicles and finally burst through the epidermis. At the apex of each conidiophore a single globose conidium is produced, measuring 10–12 μ diameter.

Penicillium silvaticum Oud. in Arch. Néerl. Sci., Ser. 2, VII (1902), p. 289.

This fungus was first recorded by Oudemans for Holland and later by Jensen (Cornell Univ. Agric. Exp. Stat. Bull. No. 315 (1912)) for America. It is interesting to note that the specimen was growing in a Petri-dish culture of agar, a situation very similar to that recorded by Oudemans. Jensen had found it amongst the soil fungi which he had isolated and it is very probable that the specimen found in the Botany Laboratory of Birmingham University was a result of an infection from soil brought into the department.

The mycelium which was pale sepia brown consisted of sterile branched septate hyphae from 3–6 μ thick, and erect fertile

hyphae up to 210 μ high. These branched penicillately, forming a head of flask shaped branches which produced very long chains of globose, smooth, hyaline conidia which were slightly tinted brown and measured 3 μ diameter. In the specimen examined by Jensen the mycelium formed non-zonate patches; our specimen, however, showed slight zonation.

Rare fungi.

During 1921 we met with the following rare fungi:

Oospora ochracea (Corda) Sacc. and Roum. Forming gregarious pinkish-grey velvety tufts on apricot jam.

Tetraploa aristata B. and Br. On grass (probably *Poa pratensis*) cut and thrown into a heap; also on living roots of grass.

Sporodesmium myrianum Desm. On *Psamma arenaria* Borth, North Wales and Sandwich, Kent.

In conclusion we thank Mr W. B. Grove for valuable help in the identification of some of the above species.

REVIEW.

British Basidiomycetae, a Handbook of the larger British Fungi, by Carleton Rea. Pp. xii + 799. £1. 10*s*. net. Cambridge University Press. 1922.

The publication of this important work, embodying the accumulated knowledge of thirty years' work in the field, has been awaited by members of the British Mycological Society with a peculiar interest.

It is well known how Mr Rea acted as Secretary to the Society for many years, practically managed the Forays singlehanded, and was responsible for the naming and listing of the huge quantities of material collected. The beautiful coloured plates, painted by Mrs Rea, were invaluable for placing on permanent record rare or new species.

The work has been delayed by printing and publishing difficulties arising from the War. The author is to be congratulated on the success of his great effort.

The Handbook will be welcomed not only by all Mycologists in this country, but also by Continental botanists, and will be assigned a worthy place among the most esteemed Fungus Floras of France, Sweden or Germany.

An appreciation of its merits can only be arrived at after a prolonged study of its contents, and considerable experience in comparing the groupings and descriptions with the Fungi themselves, but even a limited practical acquaintance with it is sufficient to demonstrate its value. The time and labour required in its compilation must have been great.

Mr Rea deals in this volume with the Basidiomycetes alone—a sufficiently large field!

His classification differs from that of Fries, to which we have been so long accustomed, and which in this country has hitherto practically held the field. Its distinctive features need not be set down here. They are clearly stated in the Introduction and in the elaborate Key to the Divisions and Genera. The system of classification is based on that of Patouillard with alterations and additions by other eminent Continental mycologists, and even an hour's study of it will render it intelligible to any one possessed of the necessary preliminary knowledge. It is ingenious, comprehensive and scientific, but whether it deserves to supersede, for practical purposes at any rate, the simpler classification of Fries is open to question.

Amateur field botanists who have learnt the Agarics on the Friesian system will not regard the new arrangement with kindly feelings, as the order of the genera is so confused that one cannot turn up well-known species without continual reference to the index. The modern school of mycologists, however, who aim at determining Agarics by microscopical features, will welcome it. The older men will demur, and the younger men may applaud.

It is to be remembered that the work is a Handbook to the larger fungi, and the less elaborate classification may be regarded as the more appropriate. However that may be, the classification followed in the present work is an interesting departure from the timeworn tradition of mycologists in this country, and deserves an opportunity of fighting its way into general favour. If, after a period of testing, it turns out to be practically superior to that of Fries and Berkeley, it will be welcomed and adopted; if not, it will still be valuable as an able and consistent attempt to arrange the great mass of material dealt with, on a fresh basis. After all, the main features of the Friesian System are still preserved.

It might have been well if in the preliminary Key, to which one naturally looks for guidance, the page where each group was to be found had been set down in consecutive order. This however is a small matter as the Index is all that could be desired, complete and well arranged, so that any single species or group of fungi can at once be found without any difficulty.

The descriptions are excellent, based of course on those of Fries, but with additional features often added, drawn either from long observation on the part of the author, or culled from the works of Continental mycologists. By the judicious use of italics, attention is drawn to the main points of distinction between neighbouring species. Measurements of spores are given for most species, and in the case of a considerable number, those of cystidia also. The former could not well have been omitted, although being variable, much stress cannot be laid on them.

As regards the measurements and shapes of cystidia it is very doubtful whether they ought to have been included at all. Their part in the life-history of a fungus is unknown, and it seems unwise and unnecessary to allow them to enter into the determination of species of Basidiomycetes, which, if they are true species at all, have a sufficient number of obvious features to separate them from one another. To study such organs is interesting and scientific, but to give them a place in the description of a species is quite a different thing.

What some will miss in these descriptions are even the briefest notes regarding the localities of the rarer species, and any hints of a popular kind as to points that might help to separate one fungus from another. No one could have supplied these better than Mr Rea, but probably he was influenced by consideration of space.

One great merit of the volume is the inclusion, up-to-date, of all species recently introduced into our British fungus-flora. These can now be recognised at once when they are met with, and the trouble of tracing them through the pages of scattered publications is avoided.

A tendency has been observed, especially in later years, to multiply species unnecessarily by laying undue stress on comparatively trivial points of difference. Neither Fries nor Berkeley nor Quélet was guilty of this error nor is Mr Rea much to blame, but many will desire that he had not had so much consideration towards these species but rather dealt with them with a master hand, so striking at the root of an evil which has been flourishing too long. Examples will occur to any experienced mycologist. We shall soon be overweighted by "species" which are not independent species, but mere varieties of others, and which add confusion to the difficulties of identification which are already so formidable.

A word may be added as to the title of the book. No doubt Mr Rea felt himself bound to follow the rules laid down by Saccardo and approved by the British Mycological Society at their Meeting at Whitby in 1904 but, *pace* Saccardo, the word BASIDIOMYCETAE is an impossible word, neither Greek, Latin nor English; it should have been BASIDIOMYCETES. Saccardo was no doubt a good mycologist, but he was a bad grammarian.

There will of course be differences of opinion as to different features in a voluminous work of this kind, but all mycologists will agree in recognising its great merit, and in giving it a hearty welcome. It is indispensable to every student of the larger fungi. The better it is known the more it will be appreciated.

It is an honour to the British Mycological Society that it has appeared under its auspices.

W. B. ALLEN

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102. Fry, Miss P., B.Sc., A.R.C.S., Botanical Laboratories, The University, Liverpool. (1922.)
103. Gadd, Mr C. H., B.Sc., Royal Botanic Gardens, Peradeniya, Ceylon. (1921.)
104. Gardner, Capt. Frederic, c/o Lloyd's Bank, Jersey, C.I. (1898.)
105. Garside, Mr S., M.Sc., F.L.S., Botanical Department, Bedford College, Regent's Park, London, N.W. 1. (1922.)
106. Gates, Professor R. R., B.Sc., Ph.D., F.L.S., King's College, London, W.C. 2 (1921.)

107. Gilchrist, Miss Grace G., B.Sc., Botanical Department, The University, Bristol. (1921.)
108. Gilbert, Dr E. M., Botanical Department, University of Wisconsin, Madison, Wis., U.S.A. (1922.)
109. Goaman, Mr J. F., Hamble, St James' Road, Hereford. (1922.)
110. Gough, Mr G. C., B.Sc., A.R.C.S., Ministry of Agriculture, Birmingham. (1923.)
111. Gould, Mr F. G., Elmhurst, Church Hill, Loughton, Essex. (1918.)
112. Gould, Mr N. G., Royal Horticultural Soc. Gardens, Wisley, Ripley, Surrey. (1922.)
113. Green, Col. C. Theodore, A.M.S., M.R.C.S. L.R.C.P. F.L.S., 31, Shrewsbury Road, Birkenhead. (1901.)
114. Green, Mr E. Ernest, F.Z.S., F.E.S., Way's End, Camberley, Surrey. (1917.)
115. Grinling, Mr C. H., B.A., 71, Rectory Place, Woolwich, S.E. 18. (1913.)
116. Gwynne-Vaughan, Professor Dame Helen, D.Sc., LL.D., F.L.S., 93, Bedford Court Mansions, London, W.C. 1. (1906.)
117. Haas, Mr P., D.Sc., Ph.D., F.C.S., University College, Gower Street, London, W.C. 1. (1921.)
118. Hadden, Mr Norman G., Underway, West Porlock, Somerset. (1911.)
119. Hake, Miss Winifrede L., 28, Lillie Road, London, S.W. 6. (1922.)
120. Hansford, Mr C. G., B.A., Microbiologist, Department of Agriculture, Jamaica. (1921.)
121. Harvey, Mrs Cecily D., Barwick in Elmet Rectory, nr. Leeds. (1910.)
122. Hasluck, Miss I. E., Green Hill Park, New Barnet, Herts. (1922.)
123. Hastings, Mr Somerville, M.S., F.R.C.S., 43, Devonshire Street, Portland Place, London, W. 1. (1913.)
124. Hawley, Sir H. C., Bart., The Manor House, Lytchett Matravers, Poole, Dorset. (1907.)
125. Hildyard, Mr F. W., 14, Lambridge, Bath. (1913.)
126. Hiley, Mr Wilfred E., M.A., F.L.S., Research Institute, School of Forestry, Oxford. (1913.)
127. Hoare, Mr A. H., 111, Blenheim Gardens, Wallington, Surrey. (1922.)
128. Holt, Mr W. H., 17, Ashville Road, Birkenhead. (1914.)
129. Honolulu, The Library, Experiment Station, S.P.A., Box 411 Hawaii. (1920.)

130. Horne, Mr A. S., D.Sc., F.L.S., F.G.S., Botanical Department, Imperial College of Science, South Kensington, London, S.W. 7. (1921.)
131. Howard, Mr H. J., F.R.M.S., "Lingfield," 6, College Road, Norwich. (1918.)
132. Hughes, Mr G. C., Chesterton, Bicester, Oxon. (1898.)
133. Humphrey, Mr C. J., Laboratory of Forest Pathology, Old Soils Building, University of Wisconsin, Madison, Wis., U.S.A. (1921.)
134. Hunter, Mr C., M.Sc., Botanical Department, The University, Bristol. (1921.)
135. Hurrell, Mr H. E., 25, Regent Street, Great Yarmouth. (1921.)
136. Illinois, The Library, University of, Urbana, Illinois, U.S.A. (1920.)
137. Issatchenko, Professor B. L., Directeur du Jardin Botanique, Petrograd, Russia. (1923.)
138. Jaczewski, Professor Arthur de, Director, Institute of Mycology and Phytopathology, Perspective Anglaise, 29, Petrograd, Russia. (1922.)
139. Johnson, Mr J. W. Haigh, M.Sc., F.I.C., F.L.S., Walton, nr. Wakefield. (1919.)
140. Johnstone, Mr R. B., 134, Cambridge Drive, Glasgow. (1908.)
141. Jones, Mr G. H., B.A., Botanical Department, Imperial College of Science, South Kensington, London, S.W. 7. (1922.)
142. Jones, Mr Robert Fowler, Austral House, Woodhall Spa, Lincolnshire. (1918.)
143. Jørstad, Mr Ivar, Statsmykolog, Botanisk Museum, Christiania, Norway. (1923.)
144. Keef, Miss Phoebe, Mortimer Lodge, Wimbledon Park, London, S.W. 17. (1921.)
145. Keilin, Dr D., Molteno Institute of Parasitology, Cambridge. (1922.)
146. Kelly, Dr Howard A., 1418, Eutaw Place, Baltimore, Md., U.S.A. (1921.)
147. Kendall, Miss C., Ministry of Agriculture, Pathological Laboratory, Milton Road, Harpenden, Herts. (1921.)
148. Kew, The Library, Royal Botanic Gardens. (1921.)
149. Kidd, Mrs Franklin, The Botany School, Cambridge. (1919.)
150. Knight, Mr H. H., M.A., The Lodge, All Saints' Villas, Cheltenham. (1914.)
151. Krieger, Mr L. C. C., 2114, N. Calvert Street, Baltimore, Md., U.S.A. (1921.)
152. Kulkarni, Mr G. S., M.Ag., Assistant Professor of Mycology, Agricultural College, Poona, India. (1922.)

153. Leicester, The Museum, City of Leicester. (1923.)
154. Line, Mr James, M.A., School of Agriculture, Cambridge. (1921.)
155. Linnean Society, The, Burlington House, Piccadilly, London, W. 1. (1919.)
156. Lister, Miss Gulielma, F.L.S., 871, High Road, Leytonstone, Essex, and Highcliff, Lyme Regis. (1903.)
157. Lloyd, Mr C. G., The Lloyd Library and Museum, 224, West Court Street, Cincinnati, Ohio, U.S.A. (1907.)
158. Lowndes, Mr A. G., M.A., Marlborough College, Marlborough, Wilts. (1922.)
159. MacCallum, Mrs B. D., M.A., D.Sc., F.L.S., Royal Botanic Gardens, Edinburgh. (1921.)
160. Macfie, Mr John William Scott, M.A., D.Sc., 21a, Alfred Street, Liverpool. (1900.)
161. Mackenzie, Miss A. D., Ministry of Agriculture, 4, Whitehall Place, S.W. 1. (1921.)
162. Mackenzie, Mr D., Afton, Busby, N.B. (1900.)
163. Main, Mr Robert, 1, Roslyn Avenue, Low Fell, Gateshead. (1918.)
164. Maire, M. René, D.Sc., Professeur à la Faculté des Sciences de l'Université, Algers, Algeria. (1907.)
165. Maitland, Mr T. D., Government Botanist, Department of Agriculture, Kampala, Uganda. (1916.)
166. Maltby, Mr G. C., 14, Northwick Road, Evesham. (1923.)
167. Marmont, Mr Basil P., Windsoredge House, Inchbrook, nr. Woodchester, Gloucestershire. (1908.)
168. Marriott, Mr St John, 37, Owenite Street, Abbey Wood, London, S.E. 2. (1920.)
169. Marshall, Mr A., 21, Potter's Hill, Aston, Birmingham. (1921.)
170. Mason, Mr E. W., M.A., M.Sc., Imperial Bureau of Mycology, 17, Kew Green, Kew, Surrey. (1921.)
171. Mason, Mrs E. W., 10, Manor Gardens, Richmond, Surrey. (1922.)
172. Mason, Mr F. A., F.R.M.S., M.S.P.A., The Laboratory, 3, Queen's Square, Leeds. (1912.)
173. Mason, Mr F. R., Assistant Mycologist, Department of Agriculture, Kuala Lumpur, Federated Malay States (1921.)
174. Matthews, Mr J. R., M.A., F.L.S., Royal Botanic Gardens, Edinburgh. (1921.)
175. McLean, Professor R. C., M.A., D.Sc., F.L.S., Botanical Department, University College, Cardiff. (1922.)
176. McCutcheon, Mr William, B.A., B.Sc., Goulburn, 89, Argyle Road, Saltcoats, N.B. (1920.)

177. McDougall, Professor W. B., University of Illinois, Urbana, Ill., U.S.A. (1921.)
178. Mehta, Professor K. C., Ph.D., Department of Biology, Agra College, Agra, U.P., India. (1921.)
179. Melbourne, The Director, Department of Agriculture, Science Branch, 605, Flinders Street, Melbourne, Australia. (1921.)
180. Melvill, Mr J. Cosmo, M.A., D.Sc., F.L.S., Meole Brace Hall, Shrewsbury. (1922.)
181. Menzies, Mr James, 117, Scott Street, Perth. (1917.)
182. Meulenbroff, Dr J. S., President, Dutch Mycological Society, Zwolle, Holland. (1921.)
183. Missouri, The Botanical Garden, St Louis, Mo., U.S.A. (1902.)
184. Miyabe, Dr Kingo, Professor of Botany, Hokkaido Imperial University, Sapporo, Japan. (1919.)
185. Montague, Mrs A., Penton, Crediton, N. Devon. (1898.)
186. Moore, Miss E. S., Ph.D., Botanical Department, Hartley College, Southampton. (1923.)
187. Moore, Mr W. C., The Botany School, Cambridge. (1922.)
188. Mounce, Miss Irene, M.A., Botanical Department, University of Manitoba, Winnipeg, Canada. (1921.)
189. Murray, Mr G. H., F.E.S., Papuan Government Service, Port Moresby, Papua, British New Guinea. (1921.)
190. Muskett, Mr A. E., Queen's University, Belfast, North Ireland. (1923.)
191. Nederlandsche Mycologische Vereeniging, c/o H. A. A. van der Lek, Bennekom, Holland. (1920.)
192. Newcastle-upon-Tyne, Literary and Philosophical Society, c/o H. Richardson, Librarian. (1902.)
193. Newman, Mr Leslie, M.A., F.I.C., F.L.S., Dip. Agr. Cantab., St Catharine's College, Cambridge. (1906.)
194. Newton, Mr W. C. F., B.Sc., John Innes Horticultural Institute, Mostyn Road, Merton, Surrey. (1922.)
195. New York Botanical Garden, Bronx Park, New York, U.S.A. (1904.)
196. Nicholson, Mr Charles, F.E.S., 35, The Avenue, Hale End, Chingford, Essex. (1916.)
197. Nicholson, Mr W. E., F.L.S., 50, St Anne's Crescent, Lewes. (1913.)
198. Noel, Miss E. F., F.L.S., 37, Moscow Court, Queen's Road, London, W. 2. (1913.)
199. North Carolina, Library, University of, Chapel Hill, North Carolina, U.S.A. (1920.)

200. Nursery and Market Garden Industries' Development Society, Ltd., Experimental and Research Station, Cheshunt, Herts. (1922.)
201. Ogilvy, Mr L., B.Sc., The Botany School, Cambridge. (1922.)
202. Ogle, Mr B. S., Hill House, Steeple Aston, Oxon. (1904.)
203. Oke, Mr Alfred William, B.A., F.G.S., F.L.S., 32, Denmark Road, Hove, Sussex. (1908.)
204. Oldham, Mr C. H., Ivy Dene, Chandler's Ford, Southampton. (1923.)
205. Ontario Agricultural College Library, Guelph, Ontario, Canada. (1920.)
206. Osborn, Professor T. G. B., M.Sc., Adelaide University, Adelaide, South Australia. (1910.)
207. Overeem, Dr C. van, Mycological Museum, Weesp, Holland. (1920.)
208. Overton, Mr H., A.C.A., Newlands, Boswell Road, Sutton Coldfield, Birmingham. (1920.)
209. Owen, Miss M. Nest. (See Mrs Franklin Kidd.)
210. Page, Miss W. M., B.Sc., Birkbeck College, Breams Buildings, Chancery Lane, London, E.C. 4. (1921.)
211. Parke, Davis & Co., Librarian, Research Department, Detroit, Mich., U.S.A. (1920.)
212. Paul, The Very Rev. David, D.D., LL.D., 53, Fountainhall Road, Edinburgh. (1899.)
213. Paulson, Mr Robert, F.L.S., F.R.M.S., Glenroy, Cecil Park, Pinner, Mdlx. (1918.)
214. Peacock, Dr H. G., The Lawn, Torquay. (1896.)
215. Pearson, Mr Arthur A., F.L.S., 59, Southwark Street, London, S.E. 1. (1911.)
216. Peck, Mr A. E., Tosti, 20, Avenue Road, Scarborough. (1918.)
217. Peltereau, E. M., Notaire honoraire, Vendôme, Loire-et-Cher, France. (1909.)
218. Perthshire Society of Natural Science, c/o James Winter (Hon. Treasurer), 35, George Street, Perth. (1919.)
219. Petch, Mr T., B.A., B.Sc., Royal Botanic Gardens, Peradeniya, Ceylon. (1911.)
220. Pethybridge, Mr G. H., Ph.D., B.Sc., Fintona, Sandford Road, Clonskeagh, Dublin. (1919.)
221. Phillips, Mr J. F., Research Officer, Forest Research Station, Deepwalls, Knysna, South Africa. (1921.)
222. Phillips, Professor Reginald W., M.A., D.Sc., F.L.S., University College of North Wales, Bangor. (1911.)
223. Plowright, Mr Charles Tertius Maclean, B.A., M.B., King Street, King's Lynn. (1901.)
224. Potter, Rev. Professor M. C., Sc.D., M.A., F.L.S., Armstrong College, Newcastle-upon-Tyne. (1896.)

225. Potts, Mr George, Benthall House, Broseley, Salop. (1910.)
226 Preston, Mr N. C., B.Sc., Harper Adams Agricultural College, Newport, Salop. (1920.)
227. Pretoria, South Africa, The Chief, Division of Botany, Department of Agriculture. (1922.)
228. Priestley, Professor J. H., D.S.O., B.Sc., F.L.S., Botanical Department, The University, Leeds. (1912.)
229. Priestley, Mrs Marion E., 2, Balmoral Terrace, Shaw Lane, Headingley, Leeds. (1919.)
230. Pusa, Imperial Mycologist, Imperial Agricultural Research Institute, Pusa, Bihar, India. (1921.)
231. Ramsbottom, Mr J., O.B.E., M.A., F.L.S., British Museum, Cromwell Road, South Kensington, London, S.W. 7. (1910.)
232. Ramsbottom, Mr J. K., c/o Geo. Monro, Ltd., 4, Tavistock St., London, W.C. 2. (1914.)
233. Rayner, Mr J. F., Swaythling, Southampton. (1902.)
234. Rayner, Miss M. Cheveley, D.Sc., Bedford College, Regent's Park, London, N.W. 1. (1921.)
235. Rea, Mrs E. A., 6, Barbourne Terrace, Worcester. (1896.)
236. Rea, Miss M. W., M.Sc., Salem House, Sydenham, Belfast, Ireland. (1920.)
237. Rea, Miss Violet, 6, Barbourne Terrace, Worcester. (1921.)
238. Rhind, Mr Donald, B.Sc., The Cottage, Alverston, nr. Bristol. (1922.)
239. Rhodes, Miss Mabel, Lister Institute, Chelsea Gardens, London, S.W. 1. (1921.)
240. Rhymes, Mr Charles, High Bois, Chesham, Bucks. (1921.)
241. Rice, Mr Cyril H., 51, Bulwer Road, Leytonstone, Essex, E. 11. (1923.)
242. Richards, Mr R. M., M.B.E., A.R.C.S., F.L.S., The Laboratory, Caledonia Estate, Province Wellesley, Straits Settlements. (1915.)
243. Ridler, Miss W. F. F., B.Sc., Botanical Department, The University, Bristol. (1921.)
244. Roberts, Mrs A. W. Rymer, The End House, Fulbrook Road, Cambridge. (1920.)
245. Robson, Mr R., M.Sc., F.Z.S., Writtle, Chelmsford, Essex. (1914.)
246. Rolfe, Mr F. W., Colonial and Indian Collections, Imperial Institute, London, S.W. 7. (1923.)
247. Roper, Miss Ida M., F.L.S., 4, Woodfield Road, Redland, Bristol. (1921.)
248. Rothamsted Experimental Station, Department of Mycology, Harpenden, Herts. (1923.)

249. Rushton, Mr W., A.R.C.S., D.I.C., St Thomas's Hospital, Medical School, Albert Embankment, London, S.E. 1. (1914.)
250. Rutgers College and State University of New Jersey, Library, New Brunswick, New Jersey, U.S.A. (1922.)
251. St Paul, Minn., U.S.A., The Library, Department of Agriculture, University Farm. (1920.)
252. Salisbury, Mr E. J., D.Sc., F.L.S., Botanical Department, University College, Gower Street, London, W.C. 1. (1921.)
253. Salmon, Mr E. S., F.L.S., South Eastern Agricultural College, Wye, Kent. (1922.)
254. Sampson, Miss K., B.Sc., Economic Botanist, Plant Breeding Station, for Wales, University College, Aberystwyth, N. Wales. (1920.)
255. Samuel, Mr Geoffrey, The University of Adelaide, South Australia. (1923.)
256. Sanderson, Mr A. R., F.L.S., Research Laboratory (Rubber Growers' Association), Petaling, Federated Malay States. (1921.)
257. Schinz, Professor Dr Hans, Botanical Garden and Museum, Zurich, Switzerland. (1921.)
258. Scott, Mr W. Murray, Wakemills, Haslemere, Surrey. (1921.)
259. Scott, Mr W. W., 5, Pemberton Gardens, Upper Holloway, London, N. 19. (1922.)
260. Searle, Mr G. Odell, B.Sc. (Agric.), Research Botanist, Linen Industry Research Association, Glenmore House, Lambeg, Lisburn, Ireland. (1920.)
261. Selborne Society, 42, Bloomsbury Square, London, W.C. 1. (1913.)
262. Sharpe, Mr C. J., Brambleside, Manor Road, Sidcup. (1905.)
263. Shaw, Mr F. J. F., D.Sc., A.R.C.S., F.L.S., Imperial Agricultural Research Institute, Pusa, Bihar, India. (1920.)
264. Small, Mr W., M.B.E., M.A., B.Sc., Mycologist, Department of Agriculture, Kampala, Uganda. (1915.)
265. Smith, Miss Annie Lorrain, F.L.S., 20, Talgarth Road, West Kensington, London, W. 14. (1899.)
266. Smith, Mr F. E., B.Sc., Department of Botany, The University, Bristol. (1922.)
267. Smith, Miss K. E., 64, Coton Road, Nuneaton. (1913.)
268. Smith, Mr Thomas, 31, Granby Road, Stockport. (1918.)
269. South London Botanical Institute, 323, Norwood Road, Herne Hill, London, S.E. 24. (1921.)

270. Stakman, Professor E. C., University of Minnesota, Minneapolis, Minn., U.S.A. (1922.)
271. Stationery Office, H.M., Superintendent of Publications, Book Department, Westminster, S.W. 1.
272. Stansfield, Miss O. P., M.Sc., Milton Mount College, Crawley, Sussex. (1922.)
273. Stirrup, Mr H. H., M.Sc., Midland Agricultural College, Sutton Bonington, Loughborough. (1922.)
274. Storey, Mr H. H., B.A., Natal Herbarium, Durban, South Africa. (1922.)
275. Sutherland, Mr G. K., M.A., D.Sc., F.L.S., 110, Brackenbury Road, Moor Park, Preston. (1914.)
276. Swanton, Mr E. W., A. L. S., Brockton, Haslemere, Surrey. (1899.)
277. Swedish Academy of Sciences, Royal, Stockholm, Sweden. (1919.)
278. Sydney, Australia. The Librarian, University of. (1922.)
279. Tabor, Mr Richard John, B.Sc., F.L.S., Botanical Department, Imperial College of Science, South Kensington, London, S.W. 7. (1914.)
280. Tagg, Mr H. F., F.L.S., Royal Botanic Garden, Edinburgh. (1921.)
281. Tatum, Mr E. J., Salisbury. (1896.)
282. Taylor, Miss Beatrice Katherine, 98, Cheyne Walk, Chelsea, London, S.W. 3. (1910.)
283. Temperley, Mr Nicholas, 4, Carlton Terrace, Low Fell, Gateshead-on-Tyne. (1918.)
284. Thomas, Mr H. Hamshaw, M.B.E., M.A., The Botany School, Cambridge. (1910.)
285. Toronto, University of, Librarian, Toronto, Canada. (1919.)
286. Tothill, Dr Vincent, c/o Trinidad Leasehold, Ltd., Norme l'Enfer Forest Reserve, Fyzabad, Trinidad, B.W.I. (1912.)
287. United States, Department of Agriculture. (1907.)
288. Victoria Technical Institute, Secretary, Second Class Scientific Library, Nagpur, C.P., India. (1922.)
289. Vines, Professor S. H., M.A., D.Sc., F.R.S., F.L.S., Langstone, Exmouth, Devon. (1915.)
290. Wadham, Mr. S. M., M.A., The Botany School, Cambridge. (1922.)
291. Wager, Mr H., D.Sc., F.R.S., F.L.S., 4, Bank View, Chapel Allerton, Leeds. (1896.)
292. Wakefield, Miss E. M., M.A., F.L.S., Herbarium, Royal Botanic Gardens, Kew. (1911.)
293. Wallis, Mr A., Westacre, Station Road, Kettering. (1921.)

294. Watson, Mr W., D.Sc., A.L.S., Taunton School, Taunton. (1923.)
295. Westerdijk, Prof. Johanna, Baarn, Holland. (1923.)
296. West Indies, Commissioner of Agriculture for, West Indian Agricultural College, St Augustine, Trinidad, B.W.I. (1921.)
297. Whetzel, Professor H. H., M.A., New York State College of Agriculture, Cornell University, Ithaca, New York, U.S.A. (1914.)
298. Whitaker, Mr F. Owen, 89, Eccleston Square, London, S.W. 1. (1921.)
299. Whitehead, Mr T., A.R.C.S., University College of North Wales, Bangor. (1920.)
300. Williams, Professor J. Lloyd, D.Sc., F.L.S., Botanical Department, University College of North Wales, Bangor. (1921.)
301. Williamson, Mrs H. S., B.Sc., Botanical Department, Imperial College of Science, South Kensington, London, S.W. 7. (1921.)
302. Wilson, Mr A. E., Southey House, College Green, Bristol. (1920.)
303. Wilson, Mr Malcolm, D.Sc., A.R.C.S., F.L.S., Royal Botanic Garden, Edinburgh. (1921.)
304. Wiltshire, Mr S. P., M.A., Imperial Bureau of Mycology, 17, Kew Green, Kew, Surrey. (1920.)
305. Wisconsin, The Library, University of, Madison, Wis., U.S.A. (1923.)
306. Wolf, Mr E. C., N.D.A., 18, Devizes Road, Salisbury. (1923.)
307. Woolhope, The Naturalists' Field Club, Hereford, c/o Mr C. S. Scobie, 2, Offa Street, Hereford. (1896.)
308. Worcestershire Naturalists' Field Club, c/o Mr F. T. Spackman, F.G.S., 190, Bath Road, Worcester. (1921.)
309. Wormald, Mr H., D.Sc., A.R.C.S., South Eastern Agricultural College, Wye, Kent. (1921.)

RULES.

Society's name and objects.

1. The Society shall be called "The British Mycological Society," and its object shall be the study of Mycology in all its branches.

Members of Society.

2. The Society shall consist of Honorary Members, Foundation Members and Ordinary Members; the number of Honorary Members shall be limited to 20, and that of Foundation Members to 100*, but the number of Ordinary Members shall be unlimited.

Honorary Members.

3. Honorary Members shall be persons of pre-eminence in Mycology, or who have rendered special service to the Society.

Foundation Members.

4. Foundation Members shall be those Members or Societies who joined the Society previous to the limit of 100 Members having been attained*.

Officers.

5. The Officers of the Society shall consist of a President, one or more Vice-Presidents, Treasurer, Secretaries, and Editor or Editors. They shall be elected annually at the Annual General Meeting of the Society.

Government of Society.

6. The government of the Society shall be vested in a Council, which shall consist of the President and other Officers for the time being, together with two or more other Members who shall be elected annually at the General Meeting, and one-half of whom shall retire each year and not be eligible for immediate re-election. The Members to retire shall be those who have been longest in office or, in case of equality, shall be determined by ballot. Ex-Presidents are *ex officio* Members of the Council.

Every Meeting of the Council shall be duly summoned by the Hon. Secretary by at least seven days' notice in writing to each Member of the Council.

* The limit of 100 Foundation Members was reached 22nd Oct., 1903.

Period of Office.

7. The Officers and Council shall hold office as from the 1st of January following their election.

Election of Members.

8. Honorary Members shall only be elected at a Meeting of the Society by a majority of the Members then present.

All Ordinary Members shall be proposed and seconded respectively by existing Members, who shall sign a certificate (see appendix) of recommendation, one at least of the proposers so certifying from personal knowledge. Every candidate for election shall sign an undertaking to abide by the Rules if elected (see appendix). They shall be elected by a majority of the Members present at any meeting of the Society or by the President and Officers of the Society.

Subscription.

9. All Ordinary Members and Societies shall pay an annual subscription of one pound, and Foundation Members five shillings, due on the 1st of January in each year. Honorary Members shall be exempt from any annual subscription.

Any Member wishing to retire from the Society shall give notice to the Hon. Secretary or Treasurer in writing before the 1st of December of the previous year.

Meetings.

10. The Society shall hold one or more Meetings annually, at a place and time determined by the Members at the preceding Annual General Meeting, or by the Council. The Annual General Meeting for the election of Officers and the transaction of other business shall coincide with the Autumn Foray.

Accounts.

11. At the Annual General Meeting of the Society in each year the Hon. Treasurer shall present duly audited accounts.

Alteration of Rules.

12. The Rules shall not be altered except by a two-thirds majority of the Members present at an Annual General Meeting. A printed copy shall be sent to every Member of the Society on election, and in the event of alteration to all Members.

APPENDIX.

Form of proposal for Ordinary Membership of the British Mycological Society.

.....

of .....

.....

being desirous of becoming an Ordinary Member of the British Mycological Society, we, the undersigned Members of the Society, certify that we consider h to be a desirable Member of the Society, and beg to recommend h for election.

Dated this day of 19

.....(From personal knowledge).

Certificate to be signed by the Candidate.

I hereby certify that I desire to become an Ordinary Member of the British Mycological Society and that I will abide by the Rules if elected.

.....

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